# DOCUMENTATION OF DECISION-AIDING SOFTWARE:

## DECISION SYSTEM SPECIFICATION

DECISIONS AND DESIGNS INC.

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by

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# CONTENTS

## FIGURES

# DECISION SYSTEM SPECIFICATION

## 1.0 INTRODUCTION

### 1.1 Purpose of the System Specification

The DECISION System Specification is a technical document written for software development personnel. Together with the DECISION Functional Description, it guides the software development effort by identifying the functional requirements and by providing structured logic diagrams that depict the flow, control, and processing of information within the system.

The System Specification is generic and is intended to guide and facilitate the preparation of the language-specific program documentation and coding that are necessary to implement and operate DECISION at an installation.

### 1.2 References

1.2.1 IBM, HIPO--A Design Aid and Documentation Technique. Technical Publication GC20-1851-0. White Plains, New York: IBM, October 1974.

1.2.2 Allardyce, Linda B.; Amey, Dorothy M.; Feuerwerger, Phillip H.; Gulick, Roy M. Documentation of Decision-Aiding Software: DECISION Functional Description. McLean, Virginia: Decisions and Designs, Inc., November 1979.

1.2.3 Allardyce, Linda B.; Amey, Dorothy M.; Feuerwerger, Phillip H.; Gulick, Roy M. Documentation of Decision-Aiding Software: DECISION Users Manual. McLean, Virginia: Decisions and Designs, Inc., November 1979.

## 1.3 Terms

1.3.1 DECISION - DECISION is an abbreviation for Decision Tree Models, reflecting the system's major area of applicability.

1.3.2 HIPO - The Specification uses the standard Hierarchy plus Input-Process-Output (HIPO) diagramming technique to depict the structural design and logical flow of the system. A legend explaining the HIPO diagramming symbols is included. Reference 1.2.1 provides a complete description of the HIPO documentation technique.

# 2.0 DESIGN DETAILS

## 2.1 Background

Systems development personnel should refer to the DECISION Functional Description, reference 1.2.2, in conjunction with the documentation contained in this Specification. The Functional Description details the decision tree model implemented by DECISION and discusses the specific functions that the software performs. In addition, systems development personnel may wish to refer to the DECISION Users Manual, reference 1.2.3.

## 2.2 General Operating Procedures

DECISION is a menu-driven system. That is, the system is designed to interact with the user by presenting a sequential hierarchy of menus and asking the user to respond by selecting one option from the current menu. If the user does not select one of the menu options, the system displays the previous menu. In this manner, the user moves up and down the hierarchy, as desired. Whenever data entry is required as a result of option selection, the system specifically requests the data and specifies the format.

The system is also designed to anticipate and be generally forgiving of procedural errors by the user.

## 2.3 System Logical Flow

DECISION is a hierarchically structured, modular system. The system structure and logical flow lends itself to presentation in the form of HIPO diagrams, which are contained in this document.

The main purpose of the HIPO diagrams is to provide, in a pictorial manner, the complete set of modular elements necessary to the operation of DECISION including all input, output, and internal functional processing. This is done by displaying input items to the process step which uses them, defining the process, and showing the resulting output of the process step.

The documentation diagrams are designed and drawn in a hierarchical fashion from the main calling routines to the detail-level operation/calculation routines. Extended written descriptions are given below a HIPO diagram whenever it is deemed necessary.

A complete explanation of the symbolic notation used in the HIPO diagrams is given in reference 1.2.1. An abbreviated legend for the symbols used in this specification is given in Figure 2-1. Note that:

a. External subroutines appear partly in the process block and partly out. Internal subroutines are shown within the process block.

b. Overview diagrams show general inputs and outputs only, whereas detail/subroutine-level diagrams show specific input/output tables and/or displays.

c. Rectangular boxes inside the input/output block areas are generally used to denote single data items. Two or more boxes are grouped to show that several data items are input/output.

d. Rectangular boxes inside the process block indicate repetitive subprocesses.

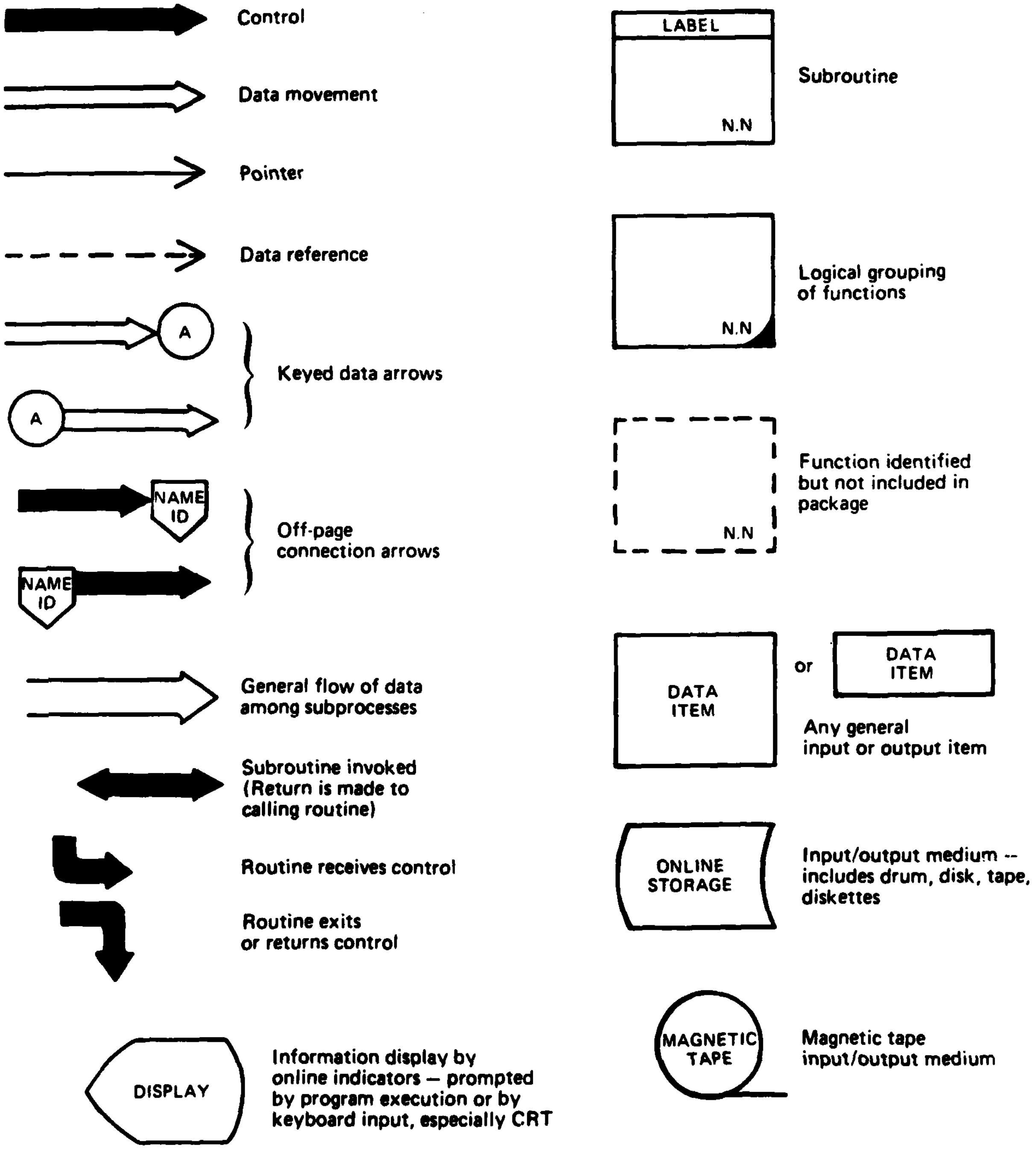

Control
Data movement
Pointer
Data reference
A
A
Keyed data arrows
NAME ID
NAME ID
Off-page connection arrows
General flow of data among subprocesses
Subroutine invoked (Return is made to calling routine)
Routine receives control
Routine exits or returns control
DISPLAY
Information display by online indicators — prompted by program execution or by keyboard input, especially CRT
LABEL
N.N
Subroutine
N.N
Logical grouping of functions
N.N
Function identified but not included in package
DATA ITEM
or
DATA ITEM
Any general input or output item
ONLINE STORAGE
Input/output medium -- includes drum, disk, tape, diskettes
MAGNETIC TAPE
Magnetic tape input/output medium

**Figure 2-1**
**LEGEND OF HIPO SYMBOLS**

The HIPO diagrams appear in the next section, which completes the System Specification.

## 2.4 HIPO Documentation

The HIPO diagram identification numbers and figure numbers used in this section stand alone; i.e., they start with 1.0, increase hierarchically, and are independent of the numbering scheme used to this point in this document.

The DECISION system comprises two subsystems: STRUCTURE, which builds and refines the decision tree model, and RUN, which produces various results based on the model and its data. Figure 2-2 is the system structure chart. Figures 2-3 and 2-4 are the subsystem charts and represent the overall program logic flows in visual tables of contents. The Visual Tables of Contents show the hierarchical structure, the functional description labels, and the diagram (chart) identifiers of the functions implemented by the DECISION subsystems.

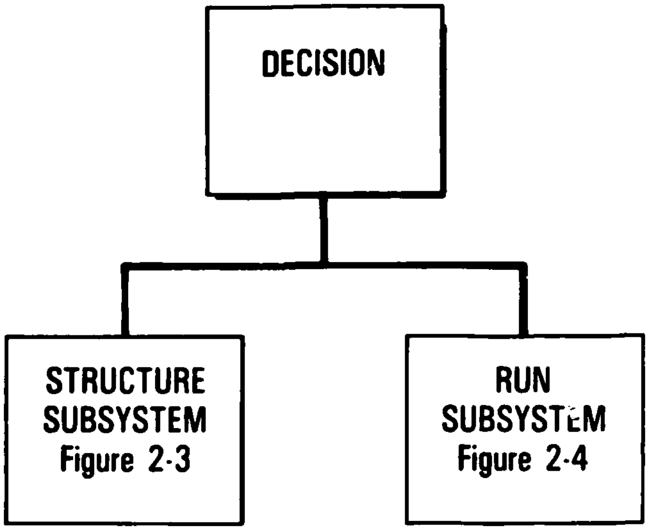


Figure 2-2
DECISION SYSTEM STRUCTURE CHART

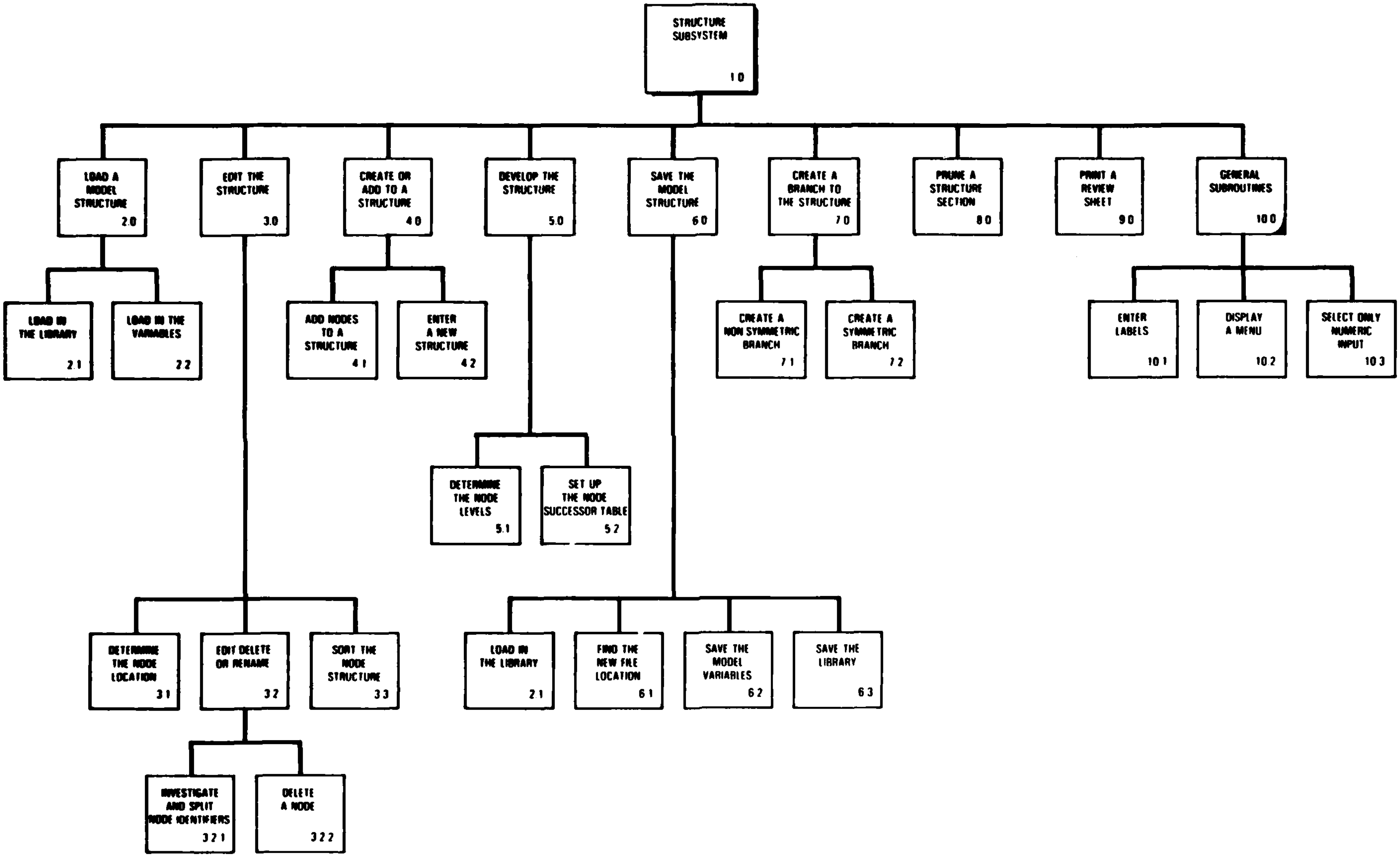

STRUCTURE SUBSYSTEM 1.0
LOAD A MODEL STRUCTURE 2.0
LOAD IN THE LIBRARY 2.1
LOAD IN THE VARIABLES 2.2
EDIT THE STRUCTURE 3.0
DETERMINE THE NODE LOCATION 3.1
EDIT DELETE OR RENAME 3.2
INVESTIGATE AND SPLIT NODE IDENTIFIERS 3.2.1
DELETE A NODE 3.2.2
SORT THE NODE STRUCTURE 3.3
CREATE OR ADD TO A STRUCTURE 4.0
ADD NODES TO A STRUCTURE 4.1
ENTER A NEW STRUCTURE 4.2
DEVELOP THE STRUCTURE 5.0
DETERMINE THE NODE LEVELS 5.1
SET UP THE NODE SUCCESSOR TABLE 5.2
SAVE THE MODEL STRUCTURE 6.0
LOAD IN THE LIBRARY 2.1
FIND THE NEW FILE LOCATION 6.1
SAVE THE MODEL VARIABLES 6.2
SAVE THE LIBRARY 6.3
CREATE A BRANCH TO THE STRUCTURE 7.0
CREATE A NON SYMMETRIC BRANCH 7.1
CREATE A SYMMETRIC BRANCH 7.2
PRUNE A STRUCTURE SECTION 8.0
PRINT A REVIEW SHEET 9.0
GENERAL SUBROUTINES 10.0
ENTER LABELS 10.1
DISPLAY A MENU 10.2
SELECT ONLY NUMERIC INPUT 10.3

Figure 2-3

**DECISION STRUCTURE SUBSYSTEM VISUAL TABLE OF CONTENTS**

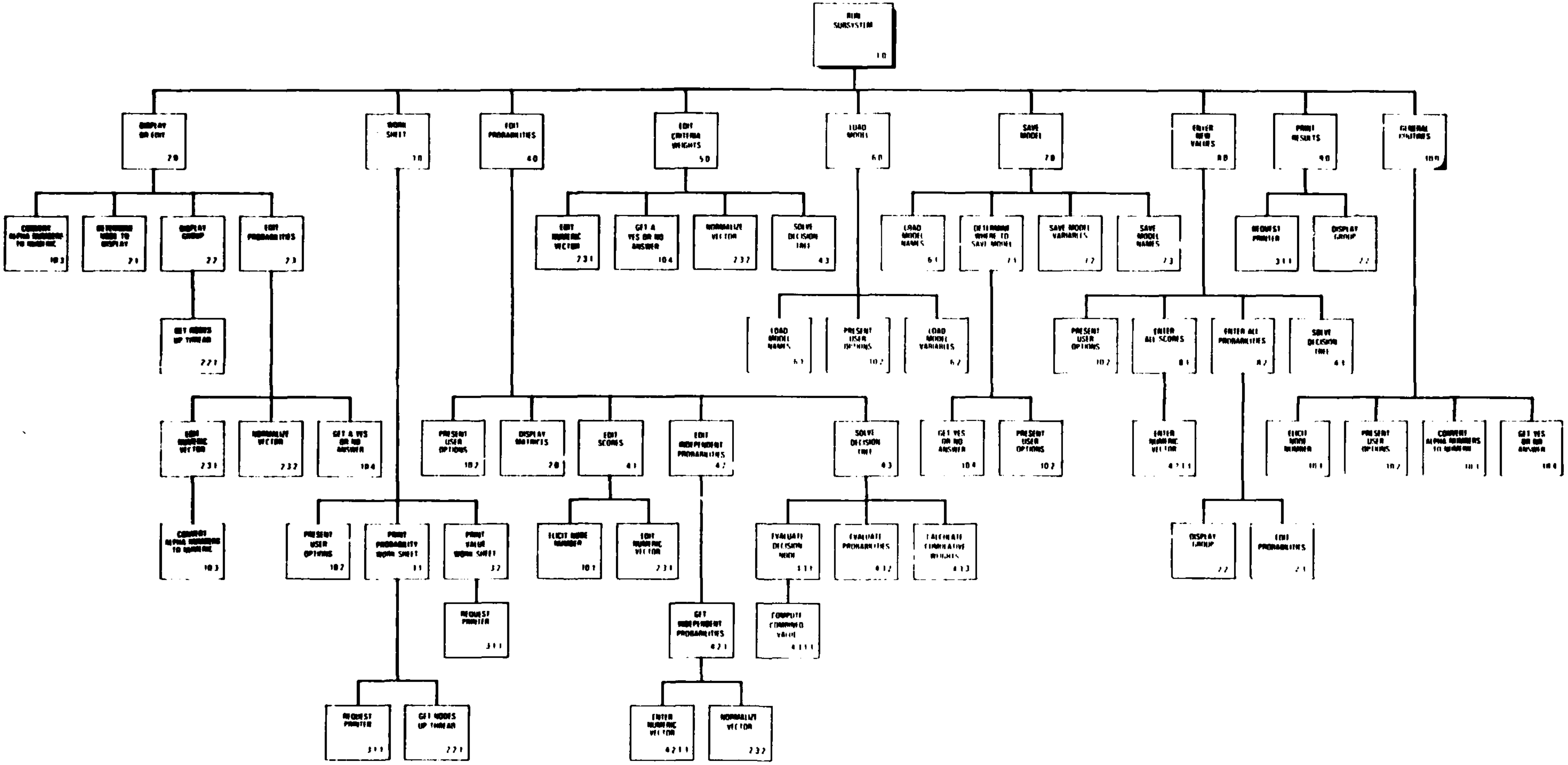
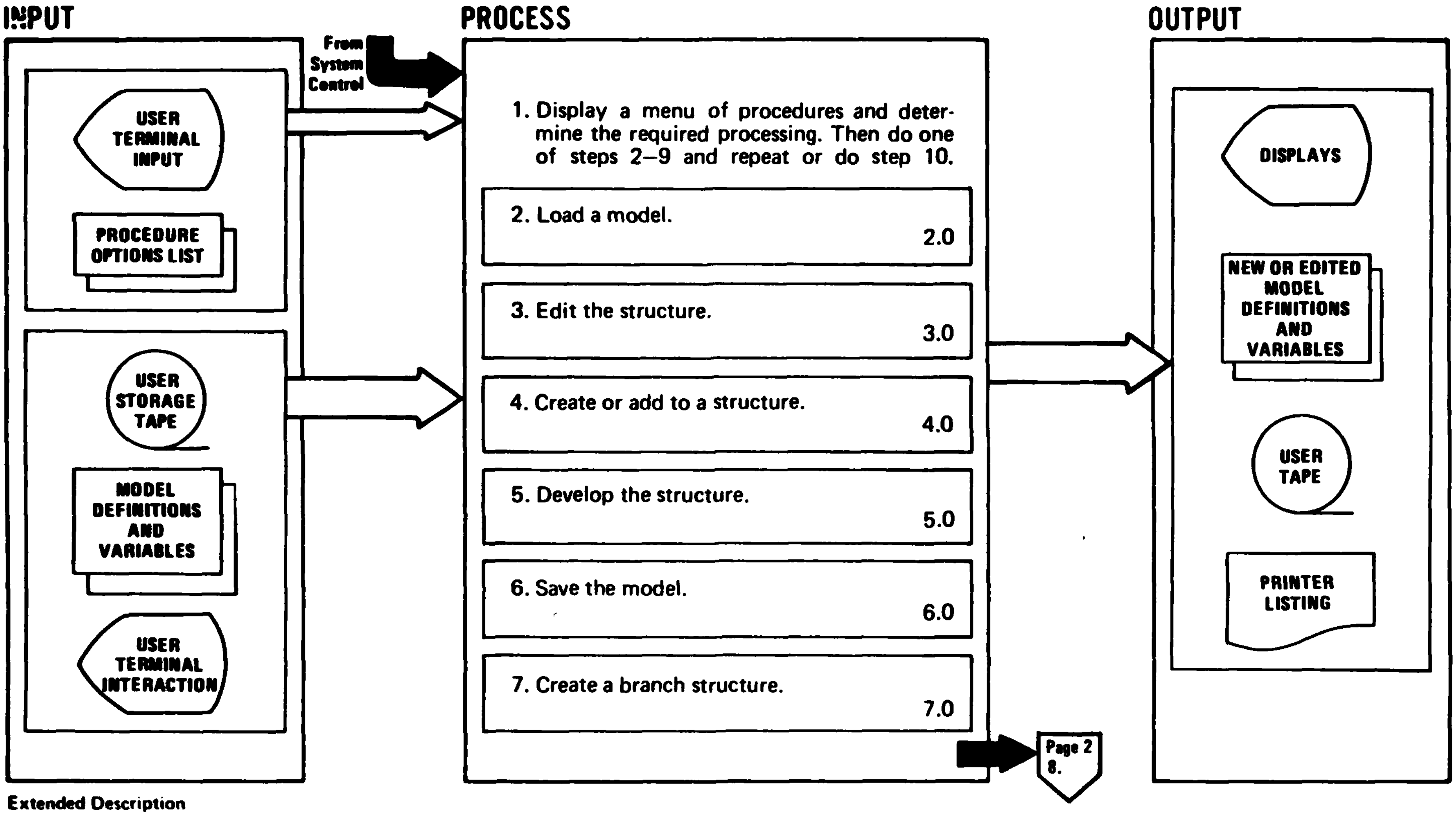

RUN SUBSYSTEM 1.0
DISPLAY OR EDIT 2.0
WORK SHEET 3.0
EDIT PROBABILITIES 4.0
EDIT CRITERIA WEIGHTS 5.0
LOAD MODEL 6.0
SAVE MODEL 7.0
ENTER NEW VALUES 8.0
PRINT RESULTS 9.0
GENERAL ROUTINES 10.0
CONVERT ALPHA NUMBERS TO NUMERIC 10.3
DETERMINE NODE TO DISPLAY 2.1
DISPLAY GROUP 2.2
EDIT PROBABILITIES 2.3
GET NODES UP THREAD 2.2.1
EDIT NUMERIC VECTOR 2.3.1
NORMALIZE VECTOR 2.3.2
GET A YES OR NO ANSWER 10.4
CONVERT ALPHA NUMBERS TO NUMERIC 10.3
PRESENT USER OPTIONS 10.2
PRINT PROBABILITY WORK SHEET 3.1
PRINT VALUE WORK SHEET 3.2
REQUEST PRINTER 3.1.1
REQUEST PRINTER 3.1.1
GET NODES UP THREAD 2.2.1
PRESENT USER OPTIONS 10.2
DISPLAY MATRICES 2.0
EDIT SCORES 4.1
EDIT INDEPENDENT PROBABILITIES 4.2
SOLVE DECISION TREE 4.3
ELICIT NODE NUMBER 10.1
EDIT NUMERIC VECTOR 2.3.1
GET INDEPENDENT PROBABILITIES 4.2.1
ENTER NUMERIC VECTOR 4.2.1.1
NORMALIZE VECTOR 2.3.2
EVALUATE DECISION NODE 4.3.1
EVALUATE PROBABILITIES 4.3.2
CALCULATE CUMULATIVE WEIGHTS 4.3.3
COMPUTE COMBINED VALUE 4.3.1.1
EDIT NUMERIC VECTOR 2.3.1
GET A YES OR NO ANSWER 10.4
NORMALIZE VECTOR 2.3.2
SOLVE DECISION TREE 4.3
LOAD MODEL NAMES 6.1
PRESENT USER OPTIONS 10.2
LOAD MODEL VARIABLES 6.2
LOAD MODEL NAMES 6.1
DETERMINE WHERE TO SAVE MODEL 7.1
SAVE MODEL VARIABLES 7.2
SAVE MODEL NAMES 7.3
GET YES OR NO ANSWER 10.4
PRESENT USER OPTIONS 10.2
PRESENT USER OPTIONS 10.2
ENTER ALL SCORES 8.1
ENTER ALL PROBABILITIES 8.2
SOLVE DECISION TREE 4.3
ENTER NUMERIC VECTOR 4.2.1.1
DISPLAY GROUP 2.2
EDIT PROBABILITIES 2.1
REQUEST PRINTER 3.1.1
DISPLAY GROUP 2.2
ELICIT NODE NUMBER 10.1
PRESENT USER OPTIONS 10.2
CONVERT ALPHA NUMBERS TO NUMERIC 10.3
GET YES OR NO ANSWER 10.4

Figure 2-4

**DECISION RUN SUBSYSTEM VISUAL TABLE OF CONTENTS**

System Program STRUCTURE Name:

Diagram ID 1.0 Description Main Routine Page 1 of 2



1. Display a menu of procedures and determine the required processing. Then do one of steps 2–9 and repeat or do step 10.

2. Load a model. 2.0

3. Edit the structure. 3.0

4. Create or add to a structure. 4.0

5. Develop the structure. 5.0

6. Save the model. 6.0

7. Create a branch structure. 7.0

**Extended Description**

The list of program procedures is displayed so that the user may select the next process to be performed. The list is displayed in menu format which allows the association of position numbers with different options in the list.

1. The user is prompted for a choice of operations. The chosen procedure is invoked via one of steps 2–9. If the user responds with blank or null input, then step 10 is executed.

2. The existence of RUN/STRUCTURE models on tape (storage) is determined and a selected model is read.

3. The structure (or model) currently defined by the program variables may be changed at this point.

4. A new structure may be entered via user interaction or nodes may be added to an existing structure.

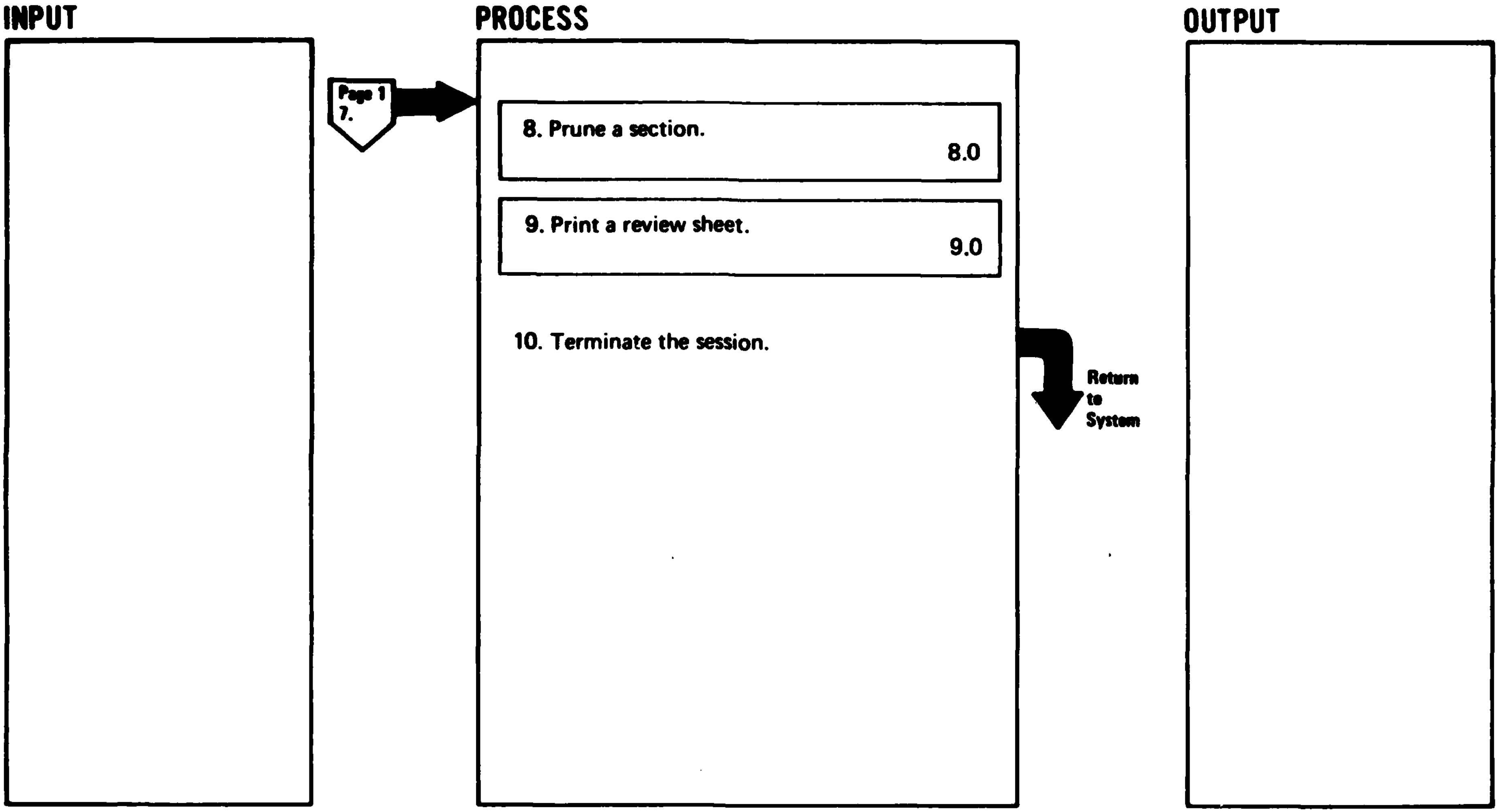
5. This step causes the completion of the model structure by setting up variables which interface with the RUN program. This step should always be performed before step 6.

6. The currently defined model structure may be stored via this step.

7. A branch or subtree may be defined and later added to a structure in procedure 4.

System Program: STRUCTURE Name:

Diagram ID: 1.0 Description: Main Routine Page: 2 of 2



INPUT

PROCESS

OUTPUT

8. Prune a section. 8.0

9. Print a review sheet. 9.0

10. Terminate the session.

**Extended Description**

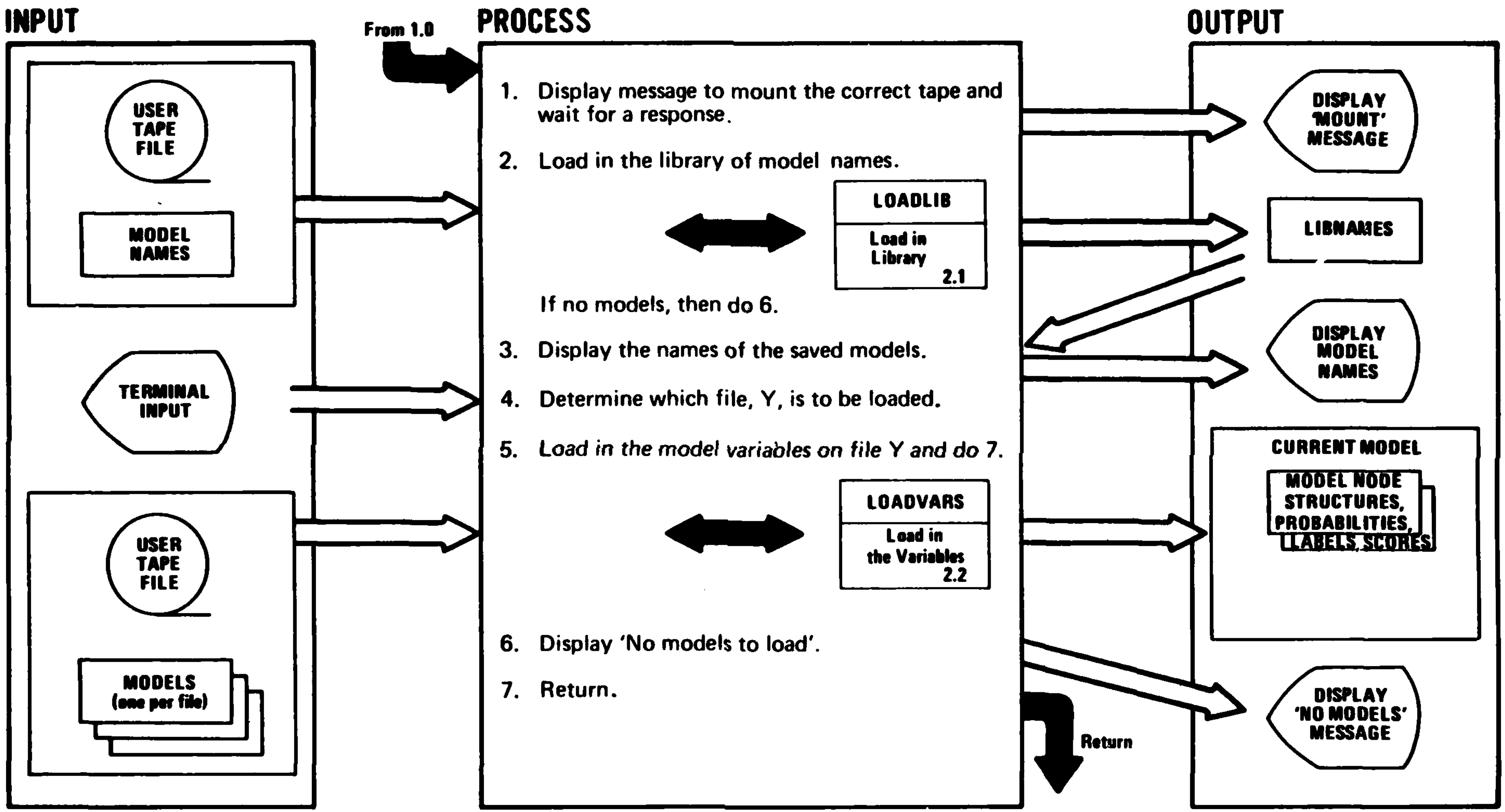
8. Groups of nodes may be deleted from the currently defined structure.

9. A printout of the structure as it is currently defined is obtained.

10. The program ends here: a restart option will cause step 1 to be executed again. When a session is terminated, all branch structures or subtrees defined are deleted.

System/Program: STRUCTURE Name:

Diagram ID: 2.0 Description Load A Model Structure Page: of



1. Display message to mount the correct tape and wait for a response.
2. Load in the library of model names.

   If no models, then do 6.
3. Display the names of the saved models.
4. Determine which file, Y, is to be loaded.
5. *Load in the model variables on file Y and do 7.*
6. Display 'No models to load'.
7. Return.

**Extended Description**

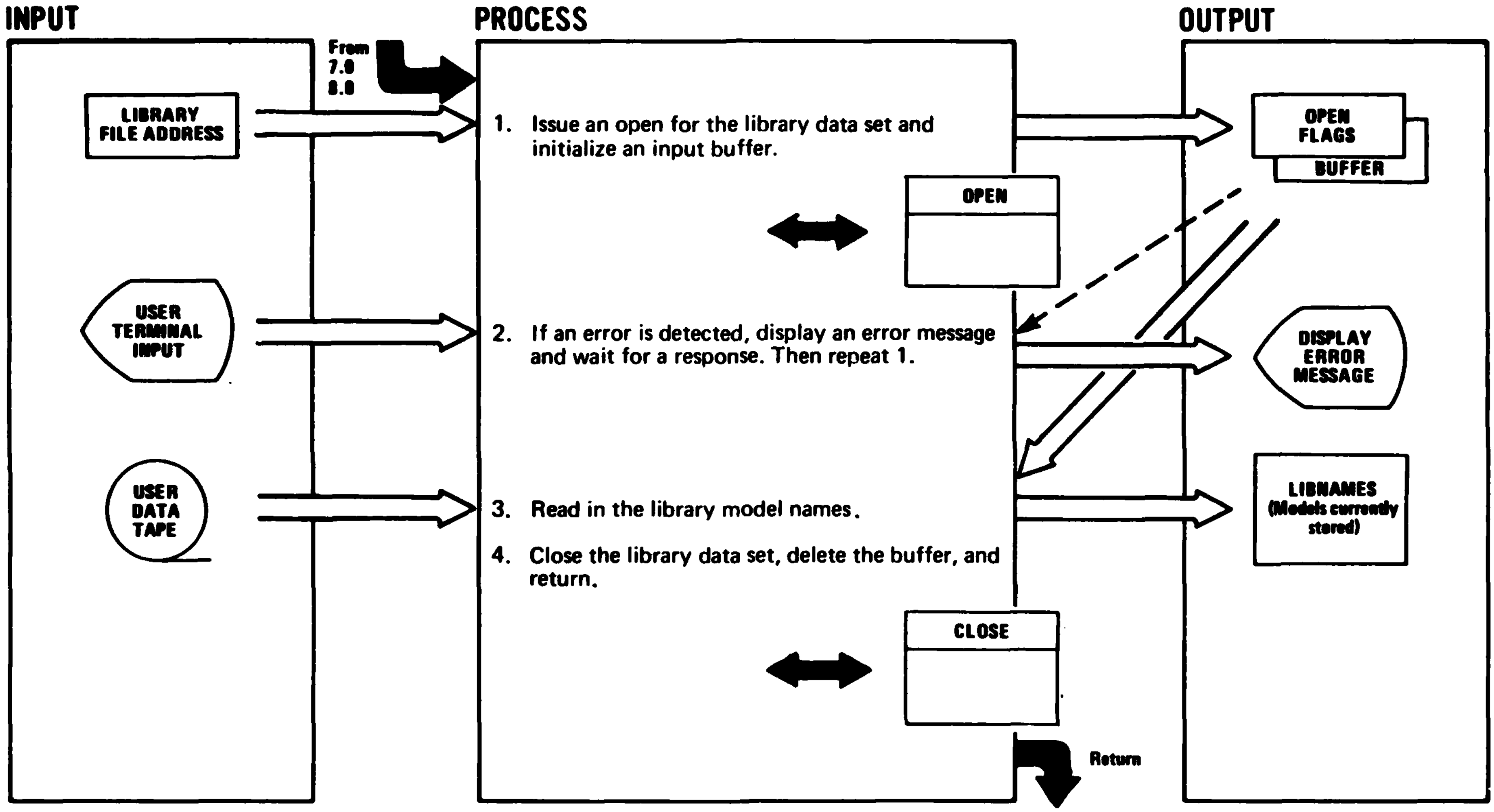
1. The user may have many tape files on which formatted models are stored. In this step, the user is prompted for a response indicating the desired tape is mounted and online.

3. The names of the models existing on the mounted tape are displayed in list or MENU format so that the user may select a model for loading.

4. The user is prompted for a model selection: the response may be the list item number or the model name. The requested model is stored in the same tape file as its position relative to the other model names in the displayed list.

System/Program: STRUCTURE Name: LOADLIB

Diagram ID: 2.1 Description Load in the Library Page: ____ of ____



1. Issue an open for the library data set and initialize an input buffer.

2. If an error is detected, display an error message and wait for a response. Then repeat 1.

3. Read in the library model names.

4. Close the library data set, delete the buffer, and return.

**Extended Description**

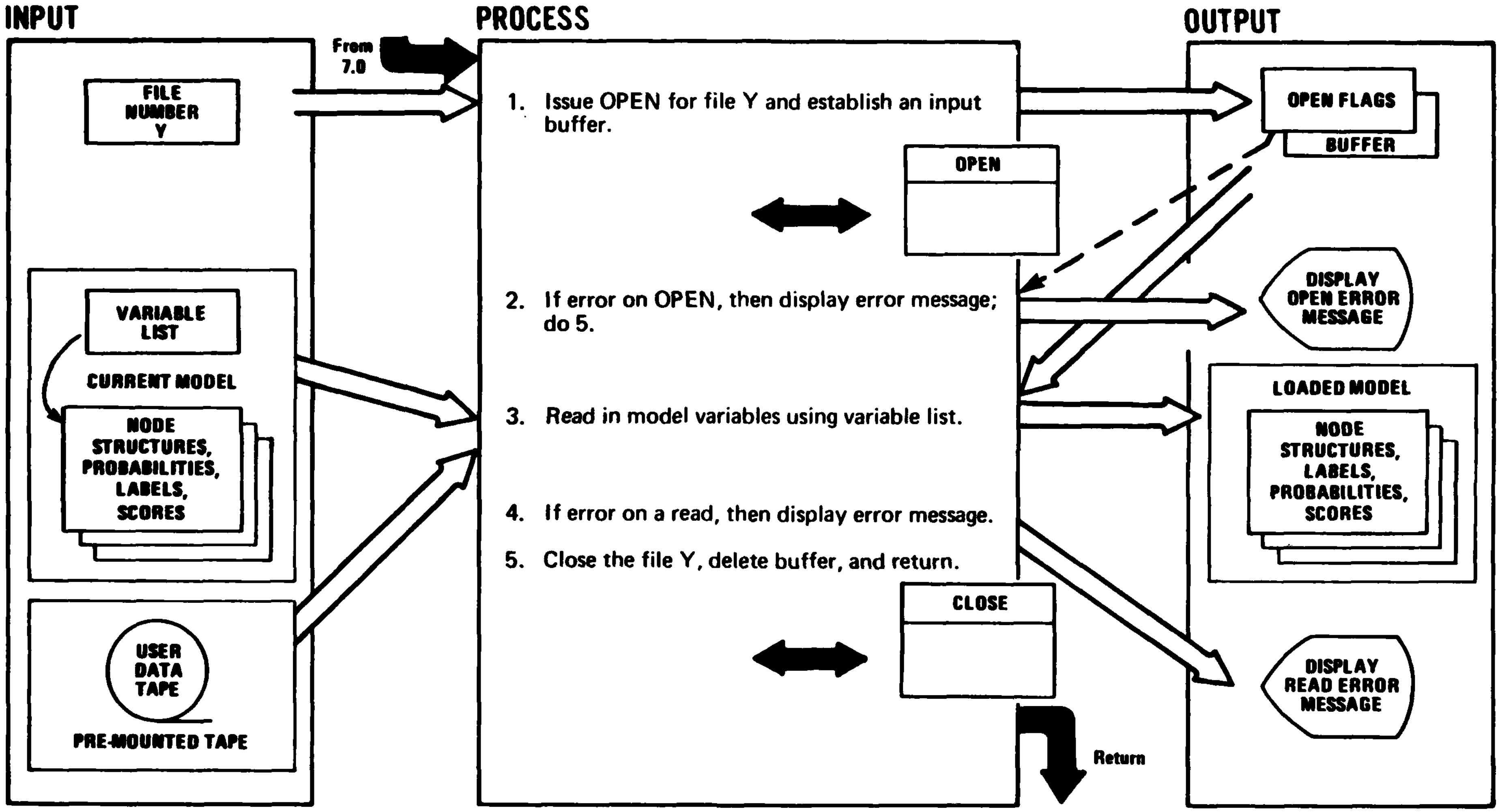
2. The library file of model names is available on each formatted data tape. The file is usually stored and retrieved as a character array and resides on the same device with model data and structure variables. A system OPEN command is needed to ensure that the data file is online and accessible for reading. An input buffer is needed and provides the link between stored information and program addressable information.

3. The library model names are retrieved from storage. The character array used for holding these model names, LIBNAMES, is of a form which facilitates display; thus, the names may all be of equal character length.

4. A system CLOSE command is issued to free the data file for later use.

System Program: STRUCTURE Name: LOADVARS

Diagram ID 2.2 Description Load in the Variables Page: 1 of 3


INPUT
PROCESS
OUTPUT
FILE NUMBER Y
VARIABLE LIST
CURRENT MODEL
NODE STRUCTURES, PROBABILITIES, LABELS, SCORES
USER DATA TAPE
PRE-MOUNTED TAPE
From 7.0
OPEN
CLOSE
Return
OPEN FLAGS
BUFFER
DISPLAY OPEN ERROR MESSAGE
LOADED MODEL
NODE STRUCTURES, LABELS, PROBABILITIES, SCORES
DISPLAY READ ERROR MESSAGE

1. Issue OPEN for file Y and establish an input buffer.

2. If error on OPEN, then display error message; do 5.

3. Read in model variables using variable list.

4. If error on a read, then display error message.

5. Close the file Y, delete buffer, and return.

**Extended Description**

3. A list of variable Names or identifiers is kept so that load and store routines will always process the variables in the same sequence order.

4. The Model variables retrieved from storage are used in all other program functions (see Diagram 1.0). The variables which must be loaded are the following:

- OUTLINE TABLE
- LABELS OF NODES
- SCORES
- PROBABILITIES
- CUMULATIVE PROBABILITIES
- NODE TYPES
- NODE INDEPENDENT PROBABILITY TAGS
- DATA LEVEL MASK
- AGGREGATE NODE INDICES
- SUCCESSOR TABLE
- LABELS OF CRITERIA
- CRITERIA WEIGHTS

1. The OUTLINE TABLE contains an element for each node in the model, sorted in increasing numerical sequence order. The value is an encoded representation of the node outline number supplied for a node when the model structure is created.

System Program: STRUCTURE Name: LOADVARS

Diagram ID: 2.2 Description Load in the Variables Page: 2 of 3

INPUT

PROCESS

OUTPUT

**Extended Description**

2. The NODE LABELS contain descriptions (one per node in the same order as the outline table) of nodes that are supplied when the model structure is created.

3. SCORES is a numeric array which contains a set of values for each node of the structure. Each set of values consists of one number per criterion defined in the model.

4. PROBABILITIES are contained in a numeric vector with a value assigned to each node *in the model structure. The elements must appear in the same order as* the associated outline numbers. When a model structure is created, the vector is null or contains zeros.

5. For each element in the node outline table, there is an associated element in the CUMULATIVE PROBABILITIES vector. The vector will contain the normalized *values of all nodes with respect to the entire model when* all PROBABILITIES have been entered.

6. The NODE TYPES are indicators of the type of calculation that is to be used in assessing final SCORES and PROBABILITIES.

7. The independent probability tags indicate groups of events that occur more than once in the tree and the probabilities of which can be assessed all at once. The number and order of elements is the same as that for OUTLINE elements.

System/Program: STRUCTURE Name: LOADVARS

Diagram ID: 2.2 Description Load in the Variables Page: 3 of 3

## INPUT

## PROCESS

## OUTPUT

**Extended Description**

8. The DATA LEVEL MASK indicates which nodes are at the data level (bottom level) versus the nodes that are aggregate or non-bottom-level nodes.

9. The AGGREGATE NODE INDICES contain the sequence numbers of elements in the model variables which correspond to only the aggregate nodes. An Aggretate node is a node which has one or more subsequent nodes contributing to it.

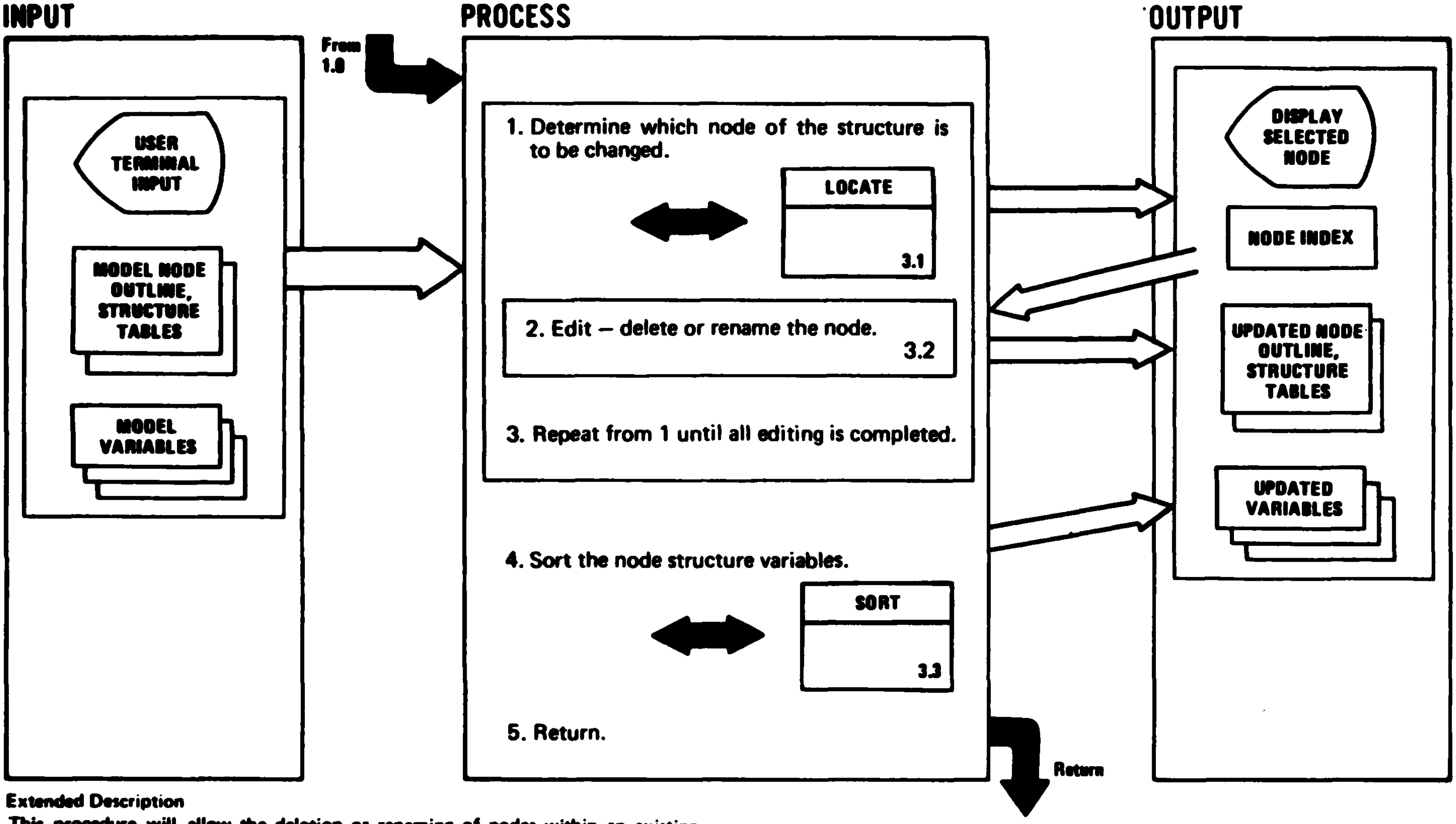
10. The SUCCESSOR TABLE is an array which contains, for each aggregate node, the set of indices of nodes which contribute to a node.

11. The CRITERIA LABELS contain the user-specified character descriptions of the criteria that are being evaluated.

12. The CRITERIA WEIGHTS contain the weights that are to be applied to the criteria when the decision tree is solved. The number of elements is equal to the number of criteria plus one for the total.

System Program: STRUCTURE Name:

Diagram ID: 3.0 Description: Edit the Structure Page: ___ of ___


INPUT
USER TERMINAL INPUT
MODEL NODE OUTLINE, STRUCTURE TABLES
MODEL VARIABLES
From 1.0
PROCESS
1. Determine which node of the structure is to be changed.
LOCATE
3.1
2. Edit – delete or rename the node.
3.2
3. Repeat from 1 until all editing is completed.
4. Sort the node structure variables.
SORT
3.3
5. Return.
Return
OUTPUT
DISPLAY SELECTED NODE
NODE INDEX
UPDATED NODE OUTLINE, STRUCTURE TABLES
UPDATED VARIABLES

Extended Description

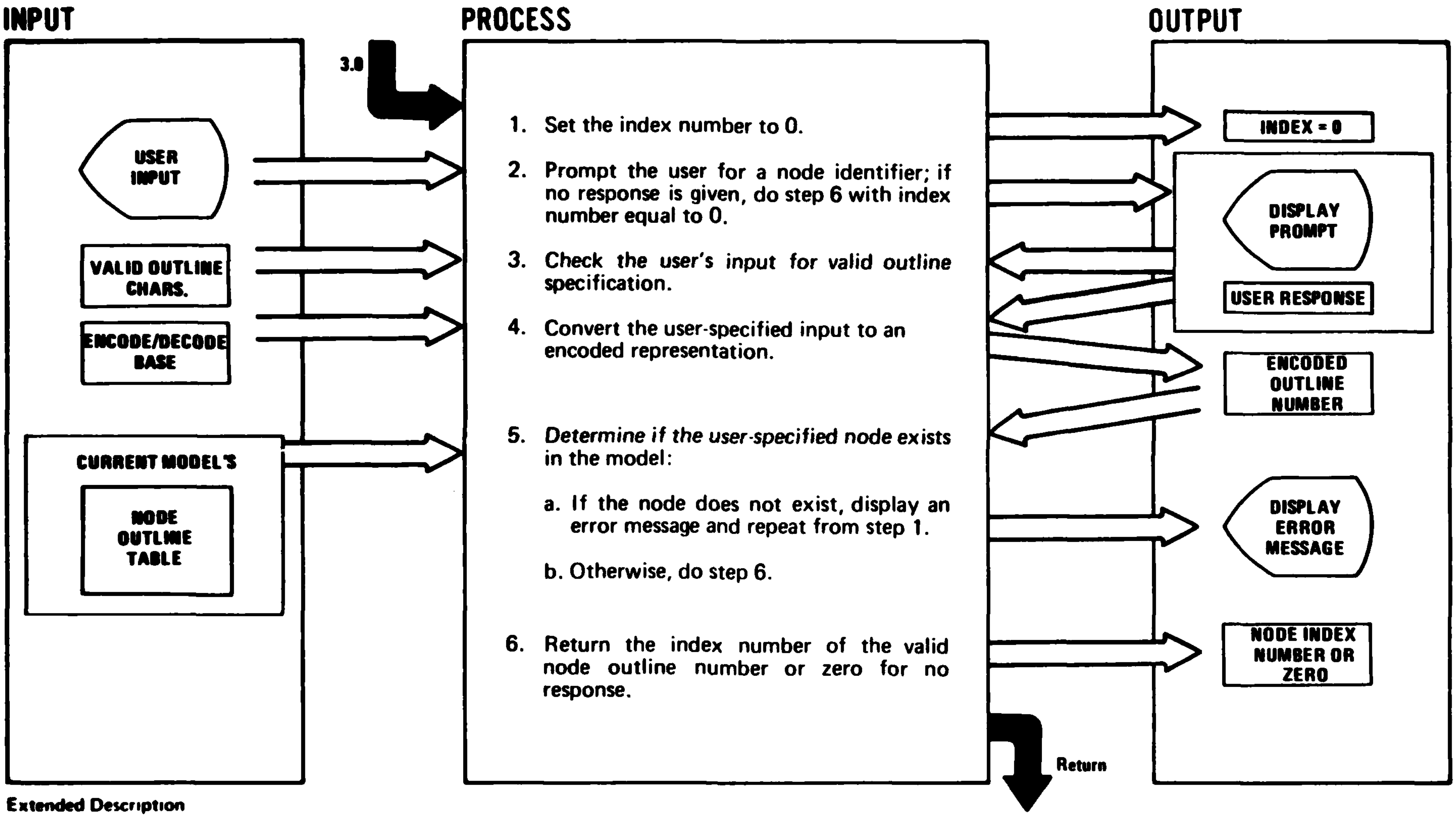
This procedure will allow the deletion or renaming of nodes within an existing structure and operates on a single node at a time. If a group or subtree of nodes is to be deleted, the user should select the "Prune a section" procedure described in diagram 8.0.

1. The user is prompted for a node identifier. This identifier corresponds to the manner in which the node was named when it was placed in the structure. The outline number is a shortened form of the node's identification. An associated index number is determined which is relative to the node outline and structure tables.

4. The node structure variables are reorganized so that associated nodes are always grouped together after the structure has been edited.

System Program STRUCTURE Name LOCATE

Diagram ID 3.1 Description Determine the Node Location Page ___ of ___



1. Set the index number to 0.

2. Prompt the user for a node identifier; if no response is given, do step 6 with index number equal to 0.

3. Check the user's input for valid outline specification.

4. Convert the user-specified input to an encoded representation.

5. *Determine if the user-specified node exists* in the model:

   a. If the node does not exist, display an error message and repeat from step 1.

   b. Otherwise, do step 6.

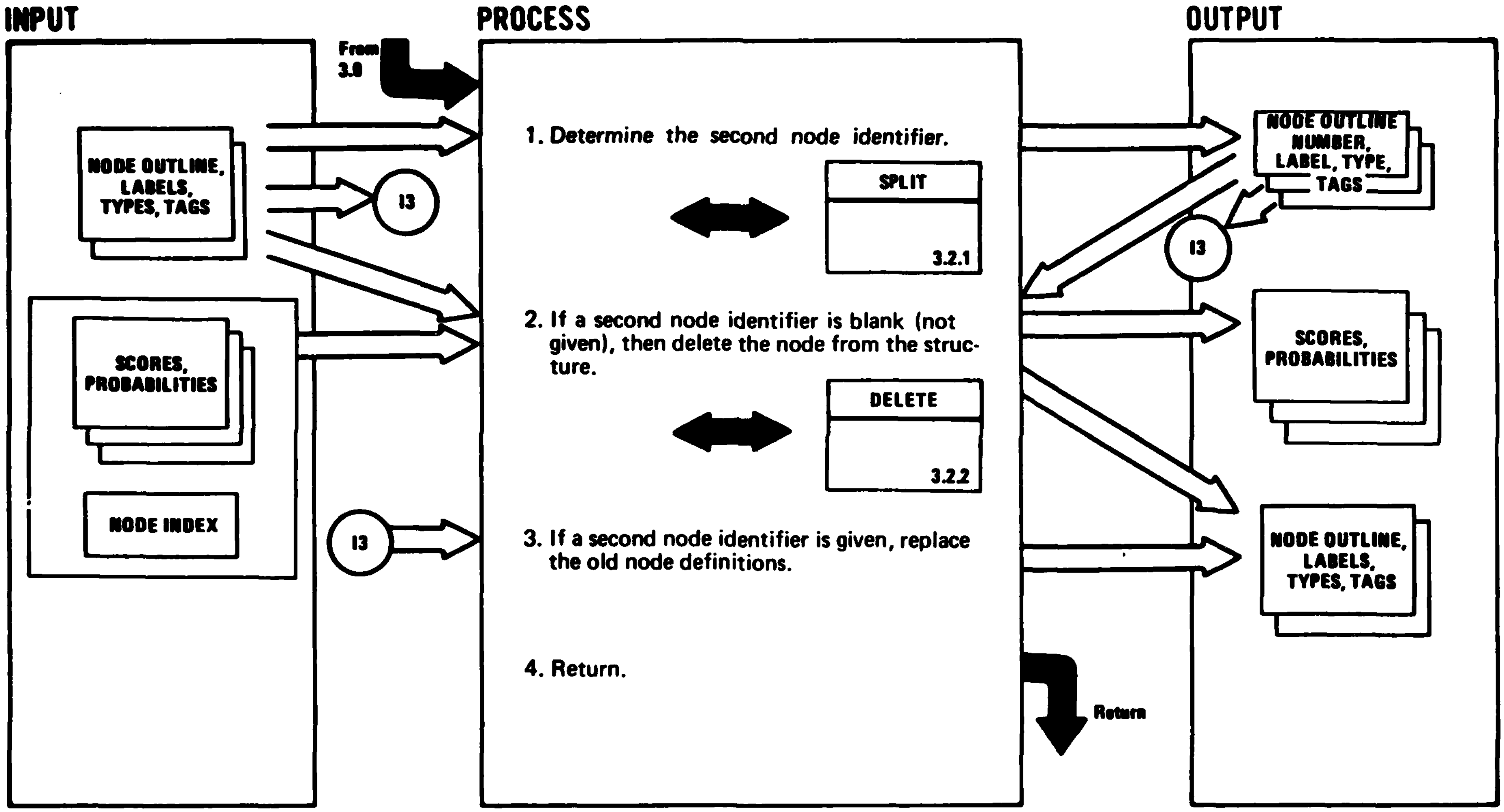
6. Return the index number of the valid node outline number or zero for no response.

**Extended Description**

**5. The existing outline table is searched for a matching encoded outline number. It is the index into this table of the matching outline number which is returned to the calling routine in step 6.**

System Program: STRUCTURE Name:

Diagram ID: 3.2 Description EDIT - Delete or Rename Page: of



1. Determine the second node identifier.

2. If a second node identifier is blank (not given), then delete the node from the structure.

3. If a second node identifier is given, replace the old node definitions.

4. Return.

**Extended Description**

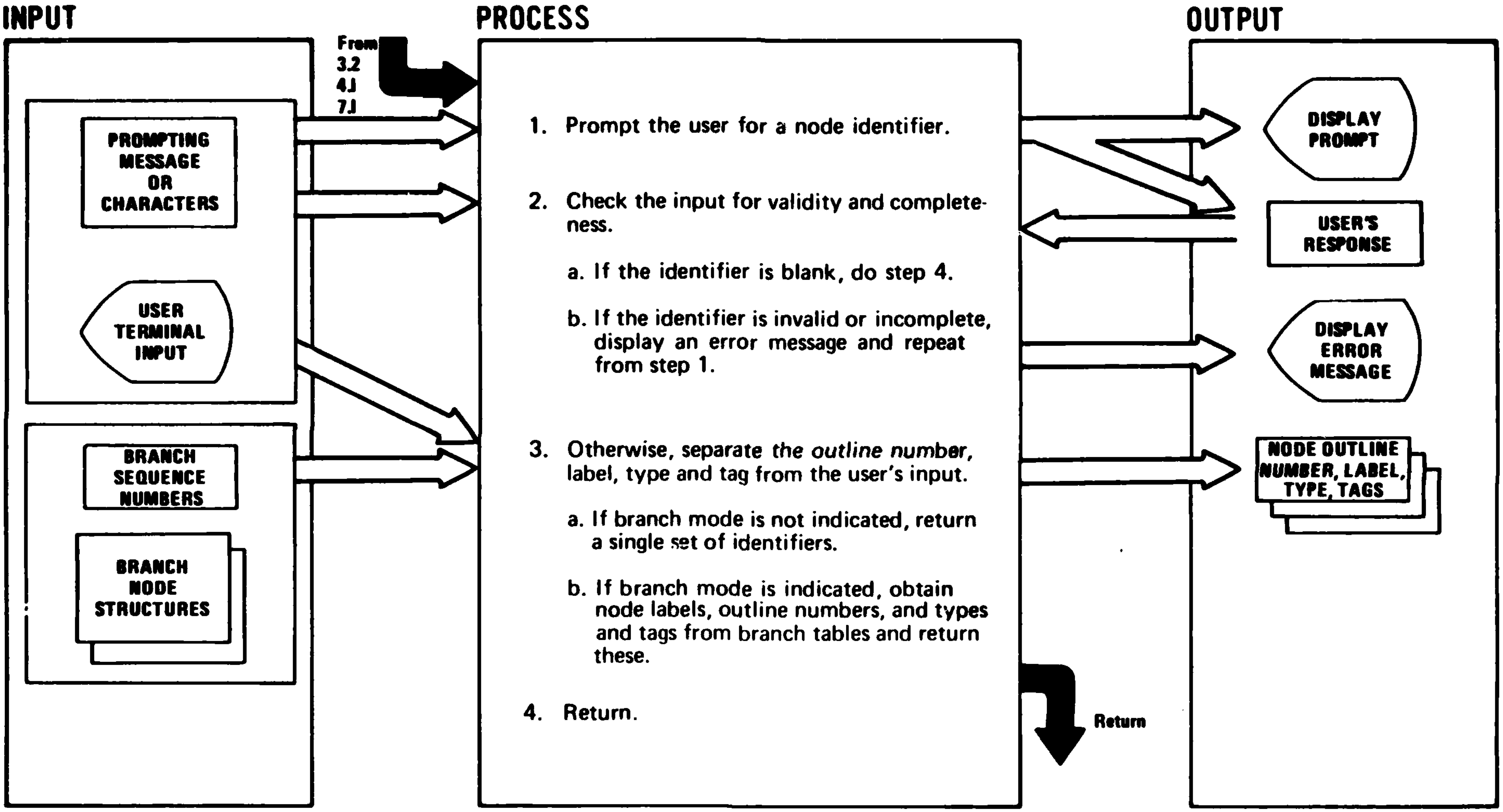
1. The user is prompted for all node identification information – the node outline number, the node label, type and probability tag. (See diagram 2.2 for a description of these items.)

2. A null entry or blank response from the user indicates that the node is to be deleted from the current structure.

3. Replace the outline number, the node label, type and tag in the appropriate arrays with the new ones.

System Program STRUCTURE Name SPLIT

Program ID 3.2.1 Description Investigate and Split Node Identifiers Page ___ of ___



1. Prompt the user for a node identifier.

2. Check the input for validity and completeness.

   a. If the identifier is blank, do step 4.

   b. If the identifier is invalid or incomplete, display an error message and repeat from step 1.

3. Otherwise, separate *the outline number*, label, type and tag from the user's input.

   a. If branch mode is not indicated, return a single set of identifiers.

   b. If branch mode is indicated, obtain node labels, outline numbers, and types and tags from branch tables and return these.

4. Return.

**Extended Description**

1. The user is required to input the identifying information for a particular node in either an existing structure or one that is currently being defined.

2. Proper node identification consists of an outline sequence number which has a hierarchical relationship to other nodes in the structure, a label or descriptive name, a node "type" and tag indicators. (The node type and probability tag indicators are optional input with default type = W for probability node and tag = blank.) The three variables are usually entered with commas or some other punctuation separating each one from the other.

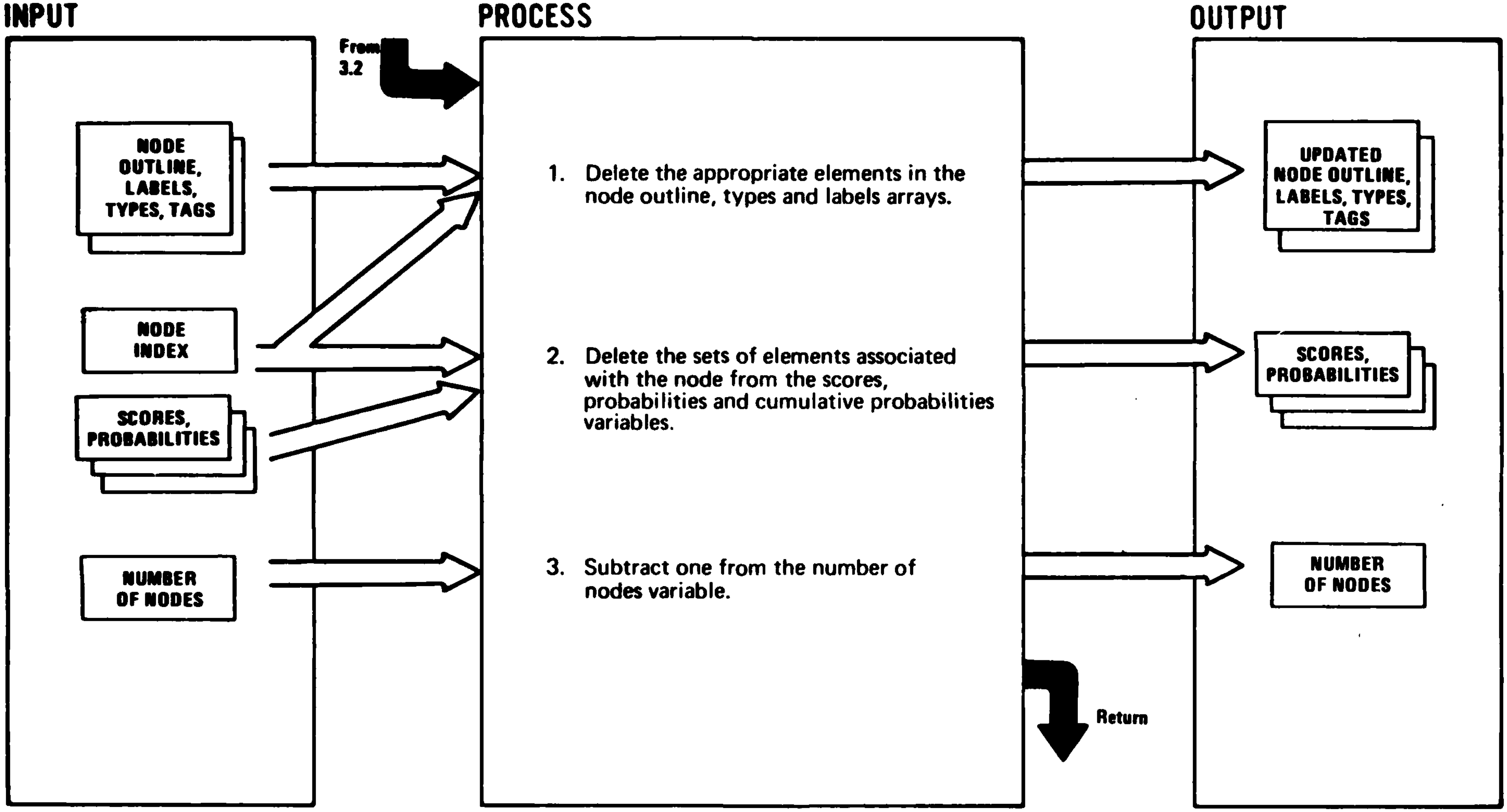
A special character, such as an asterisk (*) or pound sign (#), should be used to designate that a group or subtree is being specified. The special character would be the first in the input line of the user's response.

3. The outline number – numerically encoded to a sufficiently large number, the label, type and tag are returned as separate variables.

If a branch or subtree is being specified, the appropriate node labels, outline numbers and types are obtained from the branch structure tables. A group of encoded outline numbers, a group of labels and the group types are all returned to the calling routine. The new outline numbers have been encoded again to agree with the node after which the branch or subtree is being placed in hierarchical fashion.

System Program STRUCTURE Name

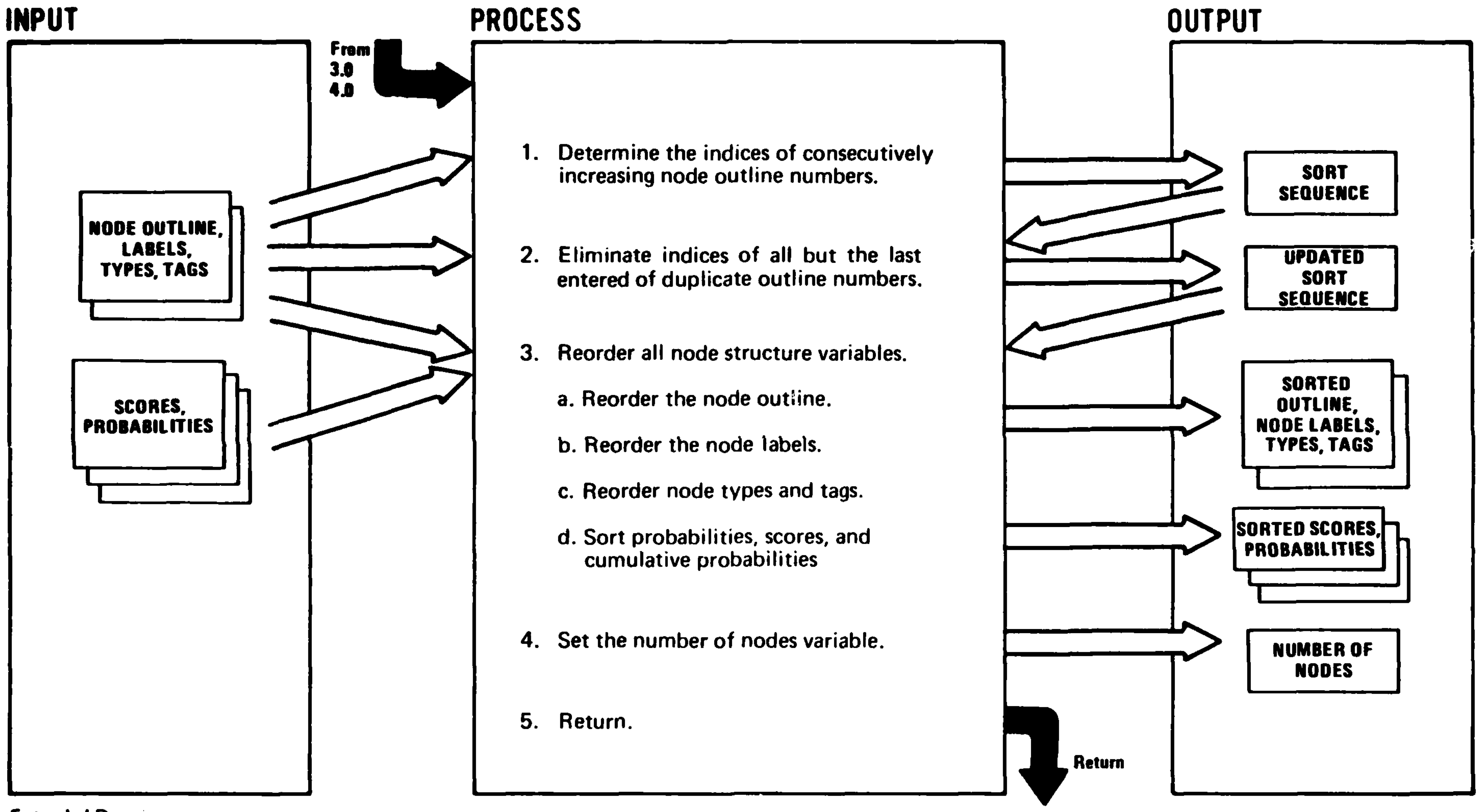
Diagram ID 3.2.2 Description Delete a Node Page of



1. Delete the appropriate elements in the node outline, types and labels arrays.
2. Delete the sets of elements associated with the node from the scores, probabilities and cumulative probabilities variables.
3. Subtract one from the number of nodes variable.

System Program STRUCTURE Name SORT

Diagram ID 3.3 Description SORT the Node Structure Page ___ of ___



1. Determine the indices of consecutively increasing node outline numbers.

2. Eliminate indices of all but the last entered of duplicate outline numbers.

3. Reorder all node structure variables.

   a. Reorder the node outline.

   b. Reorder the node labels.

   c. Reorder node types and tags.

   d. Sort probabilities, scores, and cumulative probabilities

4. Set the number of nodes variable.

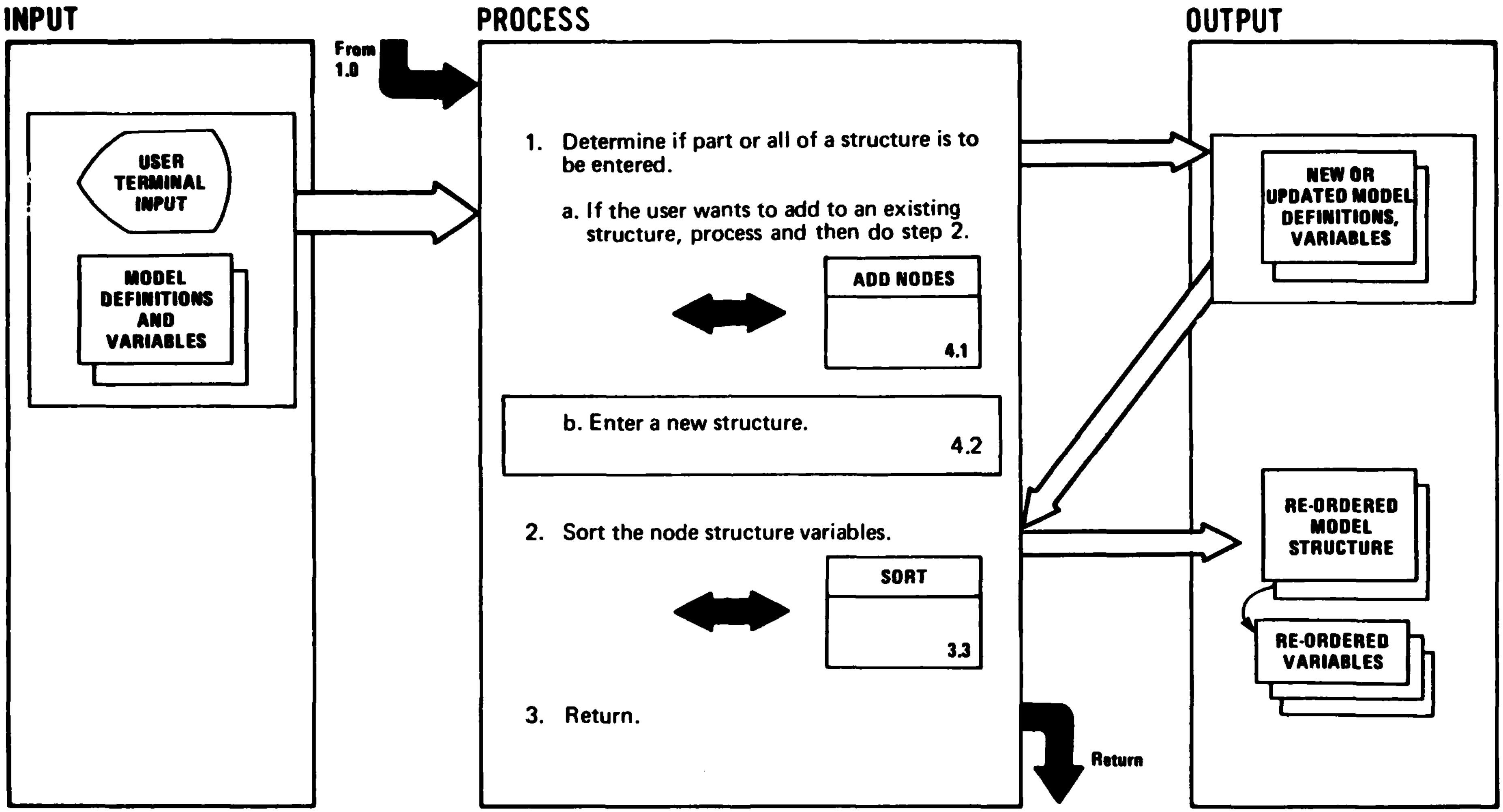
5. Return.

Extended Description

1. The relative indices or locations in the numerically encoded set of outline numbers in increasing value are determined. These indices constitute the sort sequence and will be used to rearrange the structure variables.

System Program STRUCTURE Name

Diagram ID 4.0 Description Create or Add to a Structure Page ___ of ___


INPUT
USER TERMINAL INPUT
MODEL DEFINITIONS AND VARIABLES
From 1.0
PROCESS
ADD NODES
4.1
4.2
SORT
3.3
Return
OUTPUT
NEW OR UPDATED MODEL DEFINITIONS, VARIABLES
RE-ORDERED MODEL STRUCTURE
RE-ORDERED VARIABLES

1. Determine if part or all of a structure is to be entered.

   a. If the user wants to add to an existing structure, process and then do step 2.

   b. Enter a new structure.

2. Sort the node structure variables.

3. Return.

**Extended Description**

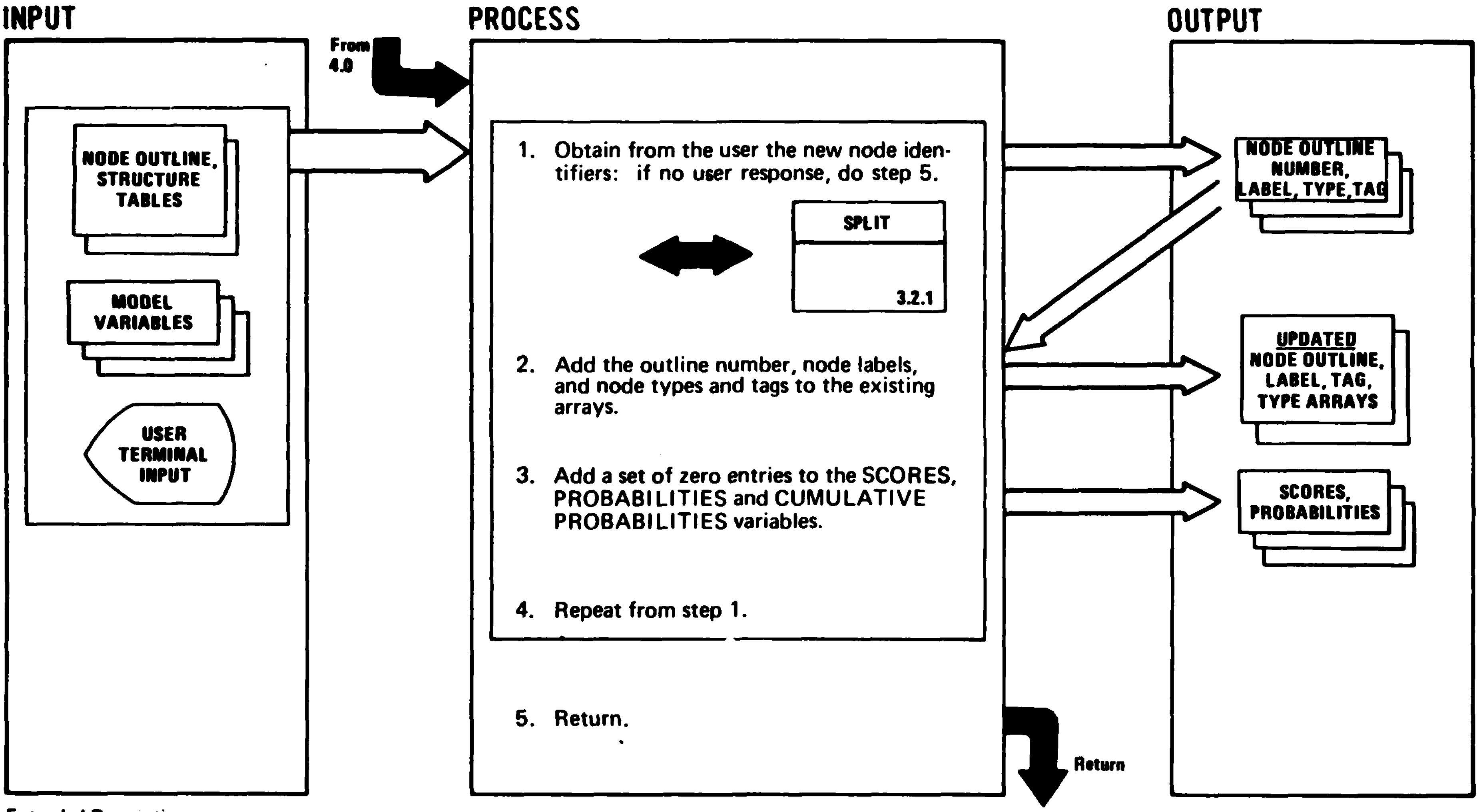
1. Request a "yes" or "no" response directly from the user to determine whether a new structure is to be entered or nodes are to be added to an existing structure.

b. If a new structure is entered, all currently defined variables of the old structure are deleted.

2. An explanation of the sorting function is given in diagram 3.3 of the STRUCTURE System Specifications.

System Program: STRUCTURE Name: ADDNODES

Diagram ID: 4.1 Description: Add Nodes to a Structure Page: ____ of ____


INPUT
PROCESS
OUTPUT
NODE OUTLINE, STRUCTURE TABLES
MODEL VARIABLES
USER TERMINAL INPUT
From 4.0
SPLIT
3.2.1
NODE OUTLINE NUMBER, LABEL, TYPE, TAG
UPDATED NODE OUTLINE, LABEL, TAG, TYPE ARRAYS
SCORES, PROBABILITIES
Return

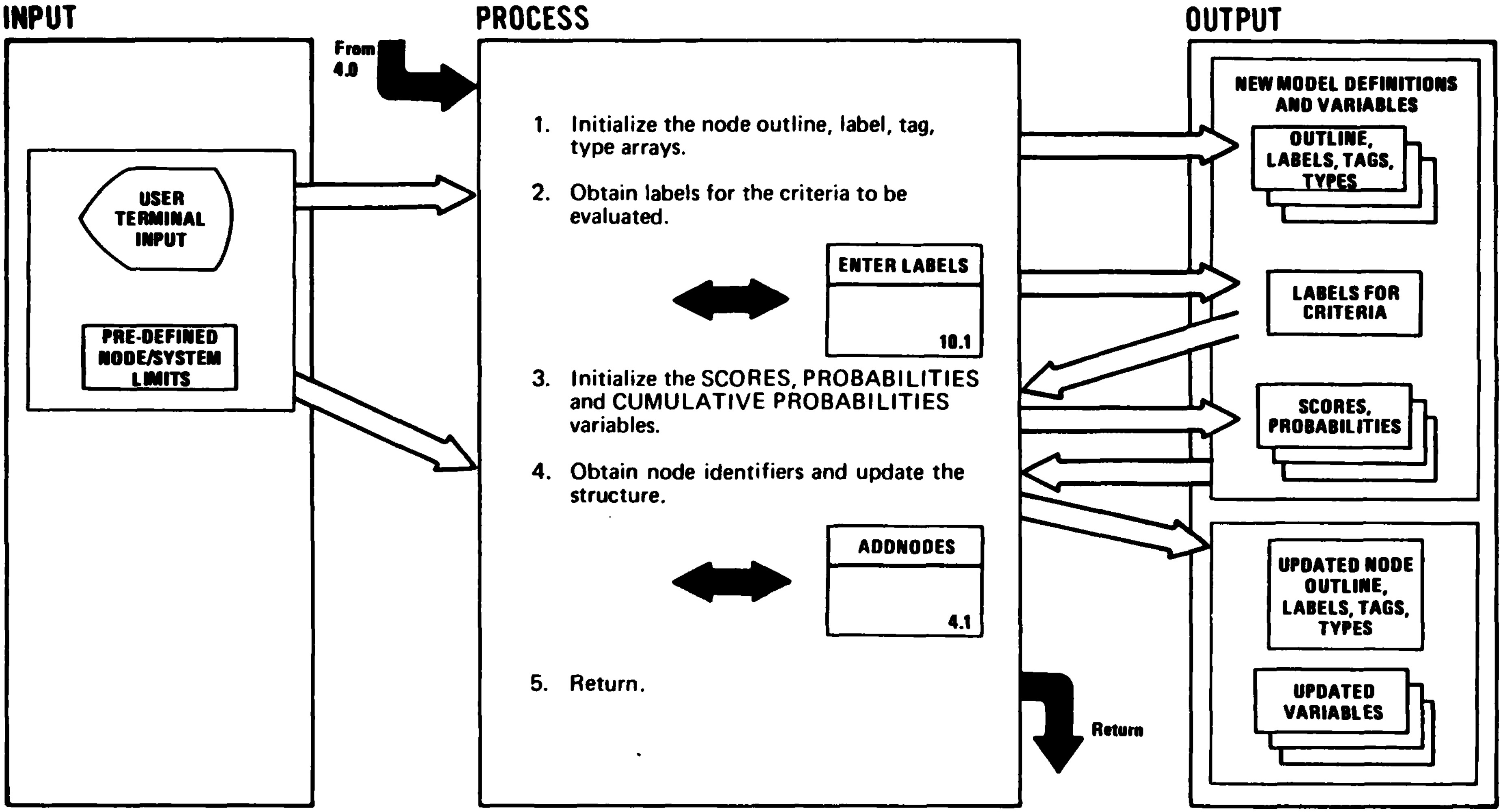
1. Obtain from the user the new node identifiers: if no user response, do step 5.
2. Add the outline number, node labels, and node types and tags to the existing arrays.
3. Add a set of zero entries to the SCORES, PROBABILITIES and CUMULATIVE PROBABILITIES variables.
4. Repeat from step 1.
5. Return.

**Extended Description**

2 - 3. Additions to previously initialized or existing variables are accomplished by extending the arrays such that the corresponding orders of associated labels, scores, types, tags, weights and decoded outline numbers are the same.

System Program STRUCTURE Name

Diagram ID 4.2 Description Enter a New Structure Page: ___ of ___



1. Initialize the node outline, label, tag, type arrays.

2. Obtain labels for the criteria to be evaluated.

3. Initialize the SCORES, PROBABILITIES and CUMULATIVE PROBABILITIES variables.

4. Obtain node identifiers and update the structure.

5. Return.

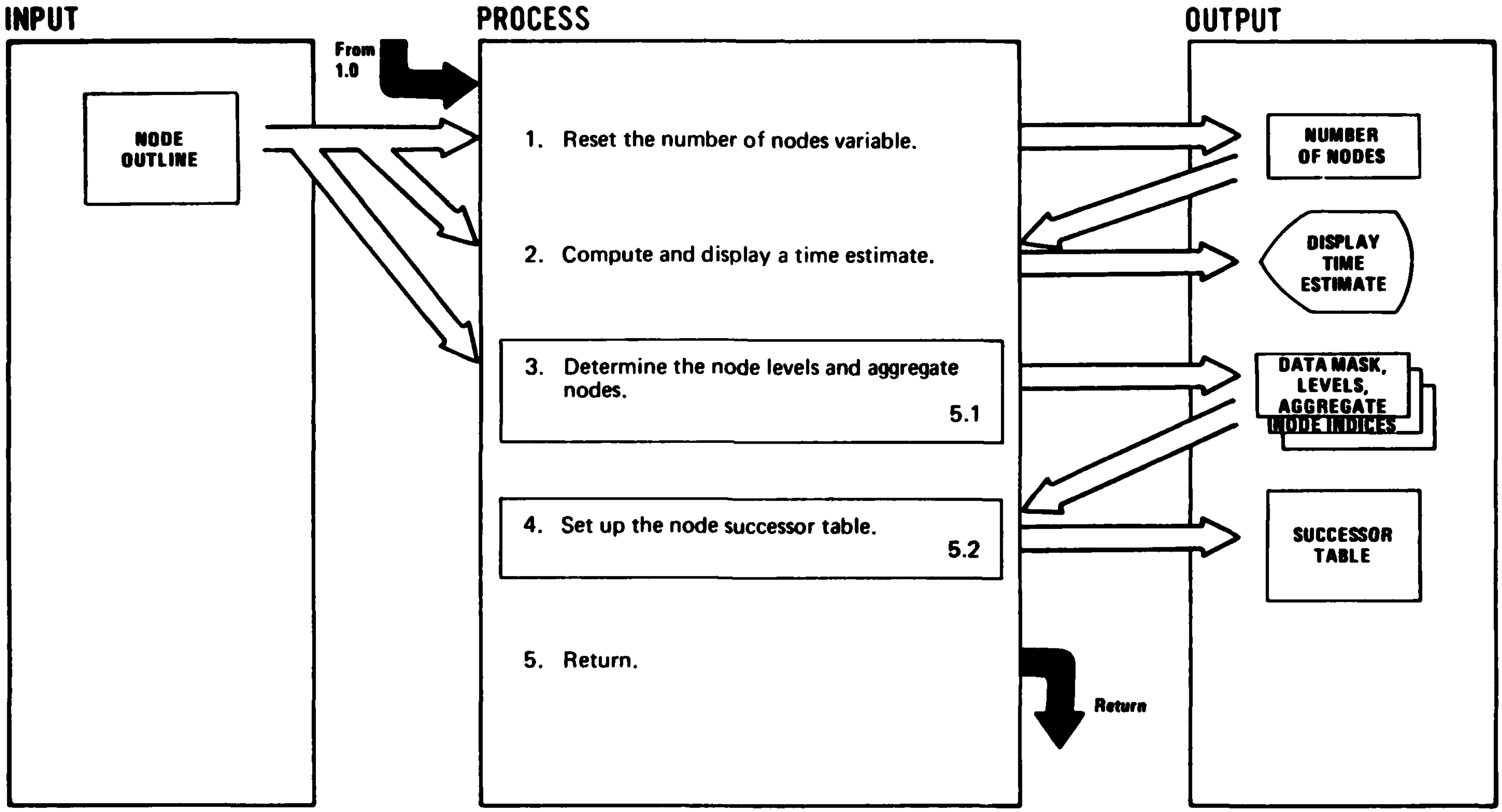
**Extended Description**

1. Initialization is caused by establishing null or blank vectors for the specified variables.

2. Labels for the criteria to be evaluated are obtained from later storage and for the determination of the length of any set of SCORES.

4. The user is prompted for input which will be used to define a hierarchical tree structure described by outline numbers, labels, tags and types of nodes within the structure.

System Program STRUCTURE Name
Diagram ID 5.0 Description Develop the Structure Page of



1. Reset the number of nodes variable.

2. Compute and display a time estimate.

3. Determine the node levels and aggregate nodes. 5.1

4. Set up the node successor table. 5.2

5. Return.

**Extended Description**

1. The number of nodes is equal to the number of entries in the outline array.

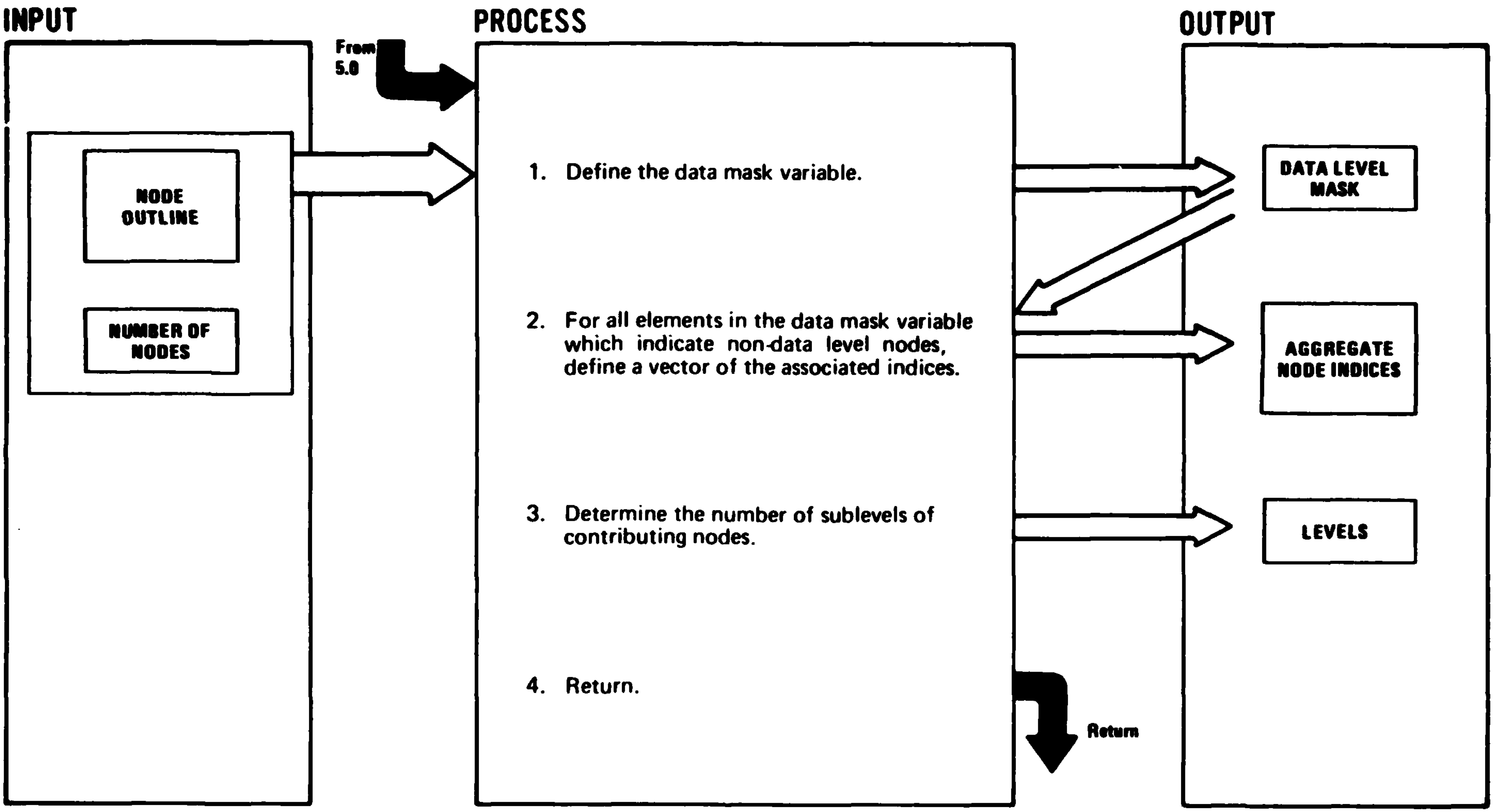
2. A rough estimate of the amount of time required to perform the developing operation may be displayed. The estimate is derived from the number of nodes in the model.

3. The data level mask indicates which nodes in the model are at the data level and which nodes are aggregate nodes. The aggregate node indices are indices into the node outline of nodes which are not at the data level. The LEVELS variable shows how far away a particular node is from the lowest level.

4. The successor table provides a set of contributing node indices for each aggregate node in the same order as aggregate node appearance in the outline.

System Program STRUCTURE Name

Diagram ID 5.1 Description Determine the Node Levels Page: ___ of ___



1. Define the data mask variable.
2. For all elements in the data mask variable which indicate non-data level nodes, define a vector of the associated indices.
3. Determine the number of sublevels of contributing nodes.
4. Return.

**Extended Description**

1. For each node in the model outline, an element is placed in a vector to indicate that node is a data level node or that it is an aggregate node having other contributing nodes.

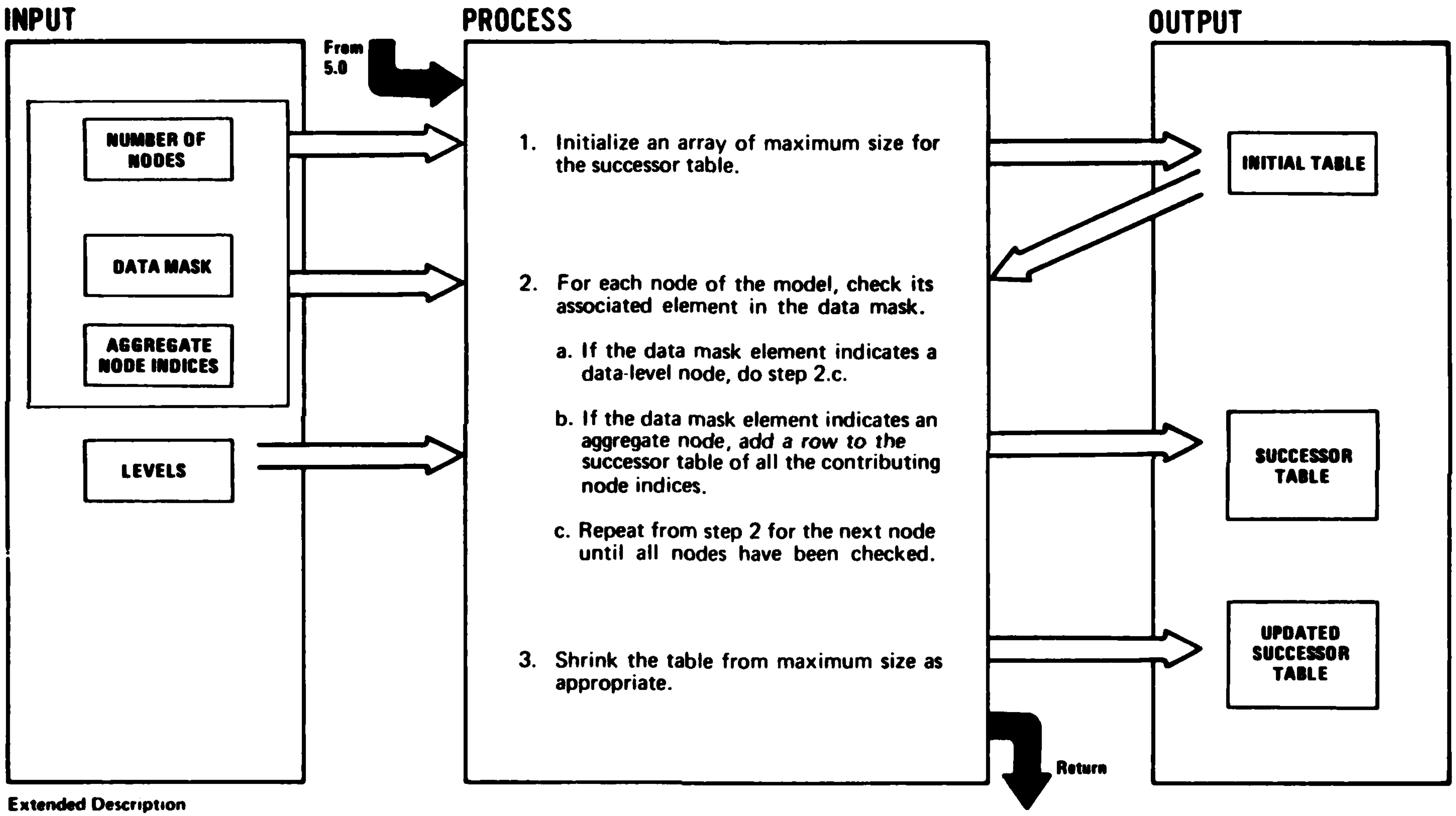
The indicator may be 0 for data level and 1 for the aggregate level or vice versa.

2. The data level mask indicator setting for each node in the outline is used to determine the aggregate node indices – indices into the node outline.

3. The farthest element or data level node from the topmost node is determined. The topmost node is assigned the number of levels between it and the data level farthest away (the depth of the path with the most sub-level tree branches). All other nodes are assigned a value equal to the top-level's minus its distance (number of levels) from the top.

System Program STRUCTURE Name

Diagram ID: 5.2 Description Set up the Node Successor Table Page ___ of ___



1. Initialize an array of maximum size for the successor table.

2. For each node of the model, check its associated element in the data mask.

   a. If the data mask element indicates a data-level node, do step 2.c.

   b. If the data mask element indicates an aggregate node, add *a row to the* successor table of all the contributing node indices.

   c. Repeat from step 2 for the next node until all nodes have been checked.

3. Shrink the table from maximum size as appropriate.

**Extended Description**

1. The maximum size table is prescribed by the number of aggregate nodes and the predefined limit to the number of contributing nodes on any single level.

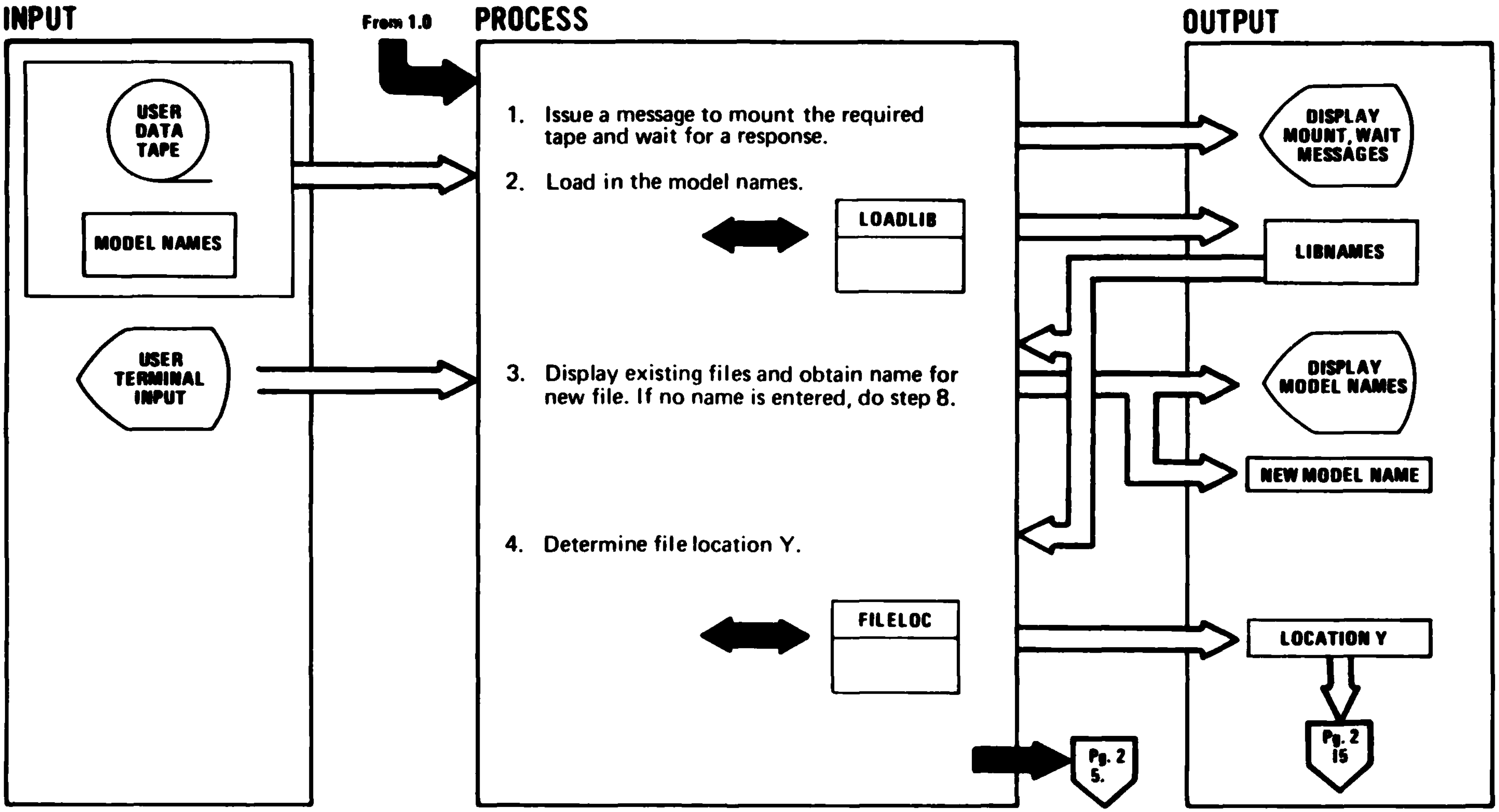
2. This procedure steps through the data mask variable in sequential order: the contributing nodes of the topmost aggregate node will be added to the successor table first.

2.b. If the nodes' associated data mask element indicates an aggregate node, then the contributing nodes are all the nodes which follow in sequential order that have an associated LEVELS number that is less than the selected nodes LEVELS numbers, provided these nodes occur before any node with equal or higher LEVELS number.

3. Since the number of elements in any set of contributing nodes may be less than the predefined limit, the number of columns (or characters) in the table may be diminished.

System Program STRUCTURE Name:

Diagram ID 6.0 Description Save the Model Structure Page 1 of 2



1. Issue a message to mount the required tape and wait for a response.

2. Load in the model names.

3. Display existing files and obtain name for new file. If no name is entered, do step 8.

4. Determine file location Y.

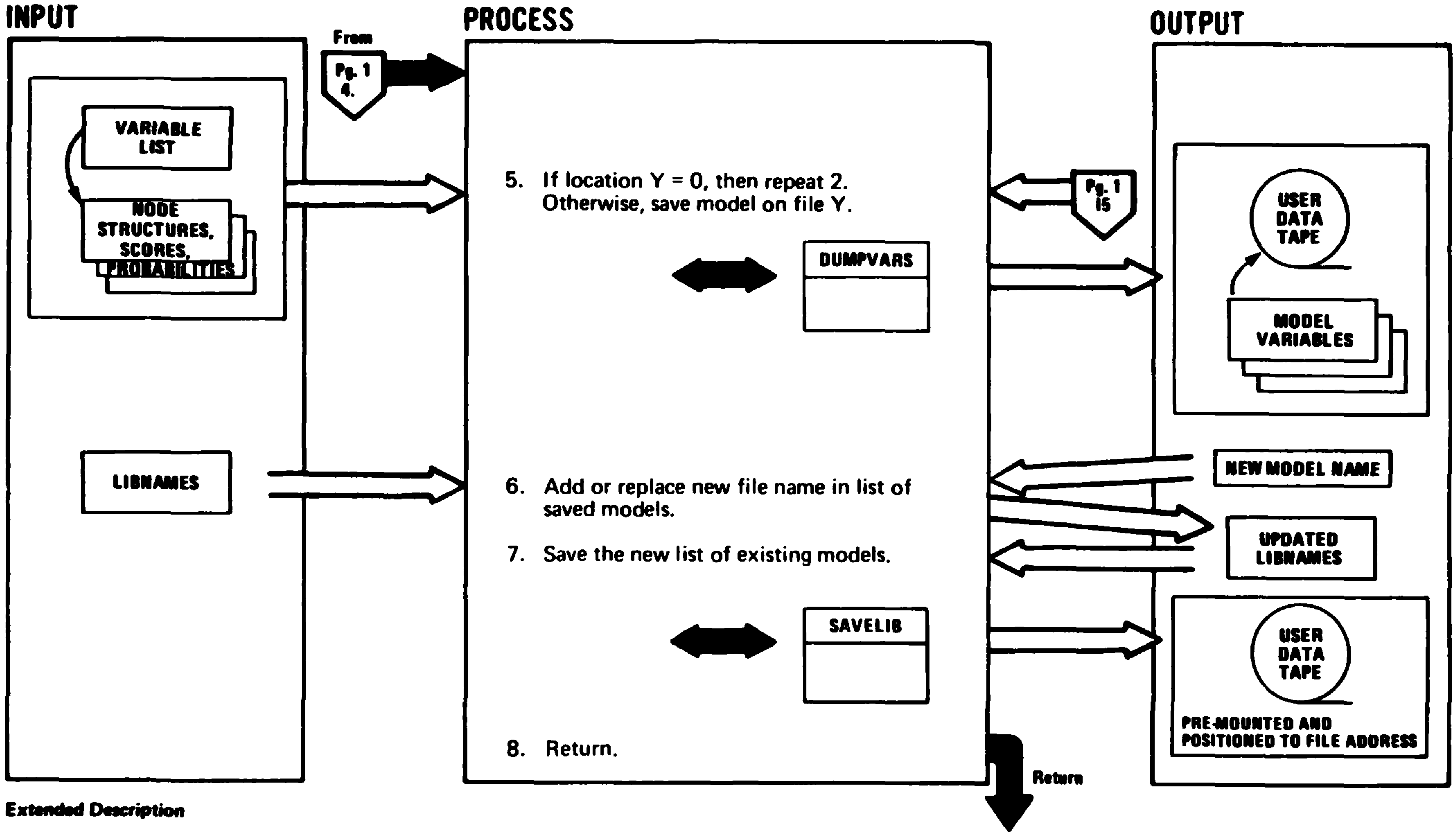
**Extended Description**

1. The computer program prompts for an indication that the desired storage file/device has been selected and placed online. Any response from the keyboard causes processing to resume.

4. The existing file structure and the amount of available space on the data tape are checked along with the user specification to determine where the model variables are to be stored.

System Program STRUCTURE Name:

Diagram ID 6.0 Description Save the Model Structure Page 2 of 2



5. If location Y = 0, then repeat 2. Otherwise, save model on file Y.

6. Add or replace new file name in list of saved models.

7. Save the new list of existing models.

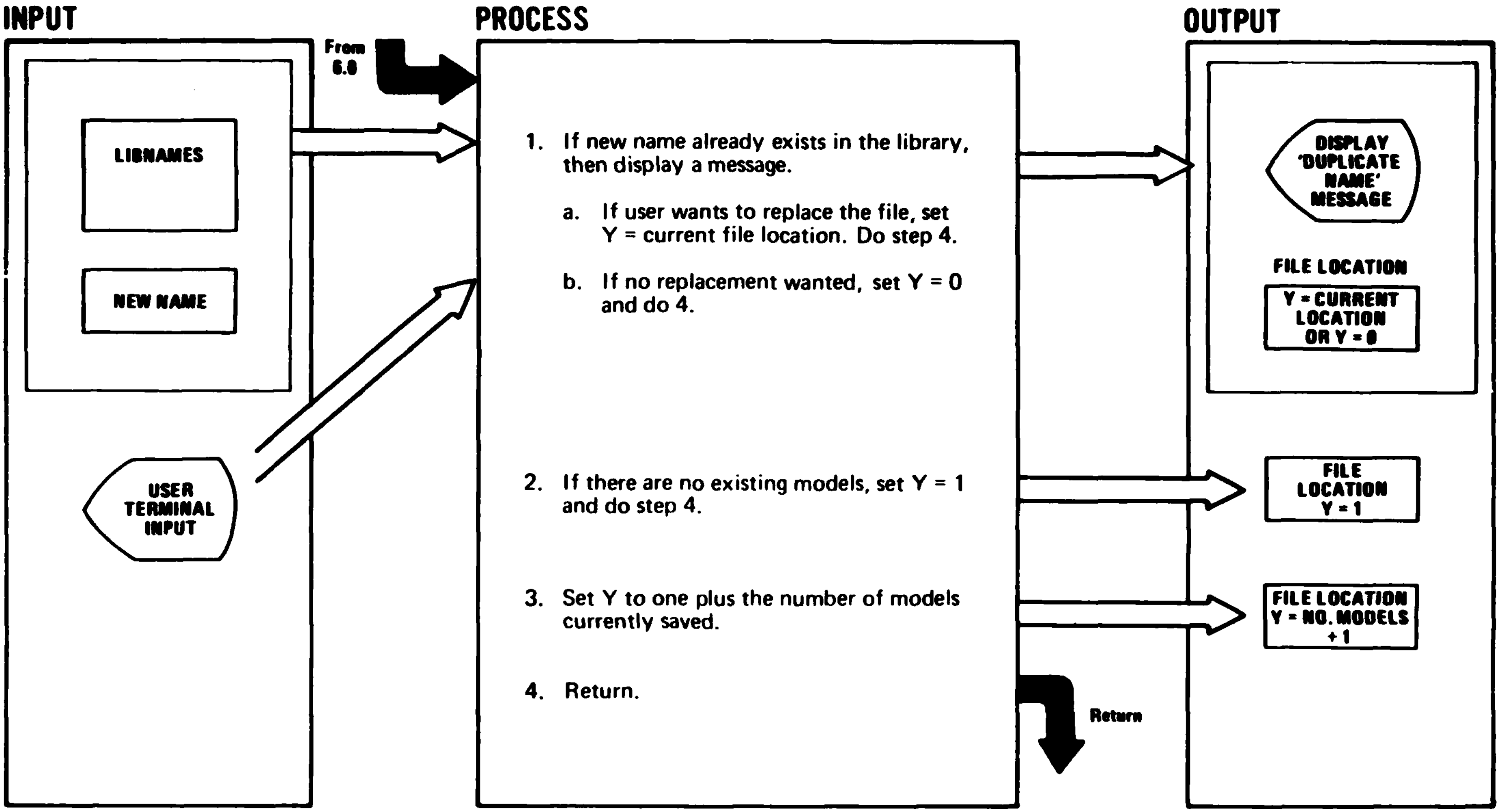
8. Return.

**Extended Description**

6. The library name list is updated to include the new file. The new model name's position in the LIBNAMES array must be the same relative position to other models stored on the device.

System Program: STRUCTURE Name: FILELOC

Diagram ID: 6.1 Description: Find the New File Location Page: ___ of ___



1. If new name already exists in the library, then display a message.

   a. If user wants to replace the file, set Y = current file location. Do step 4.

   b. If no replacement wanted, set Y = 0 and do 4.

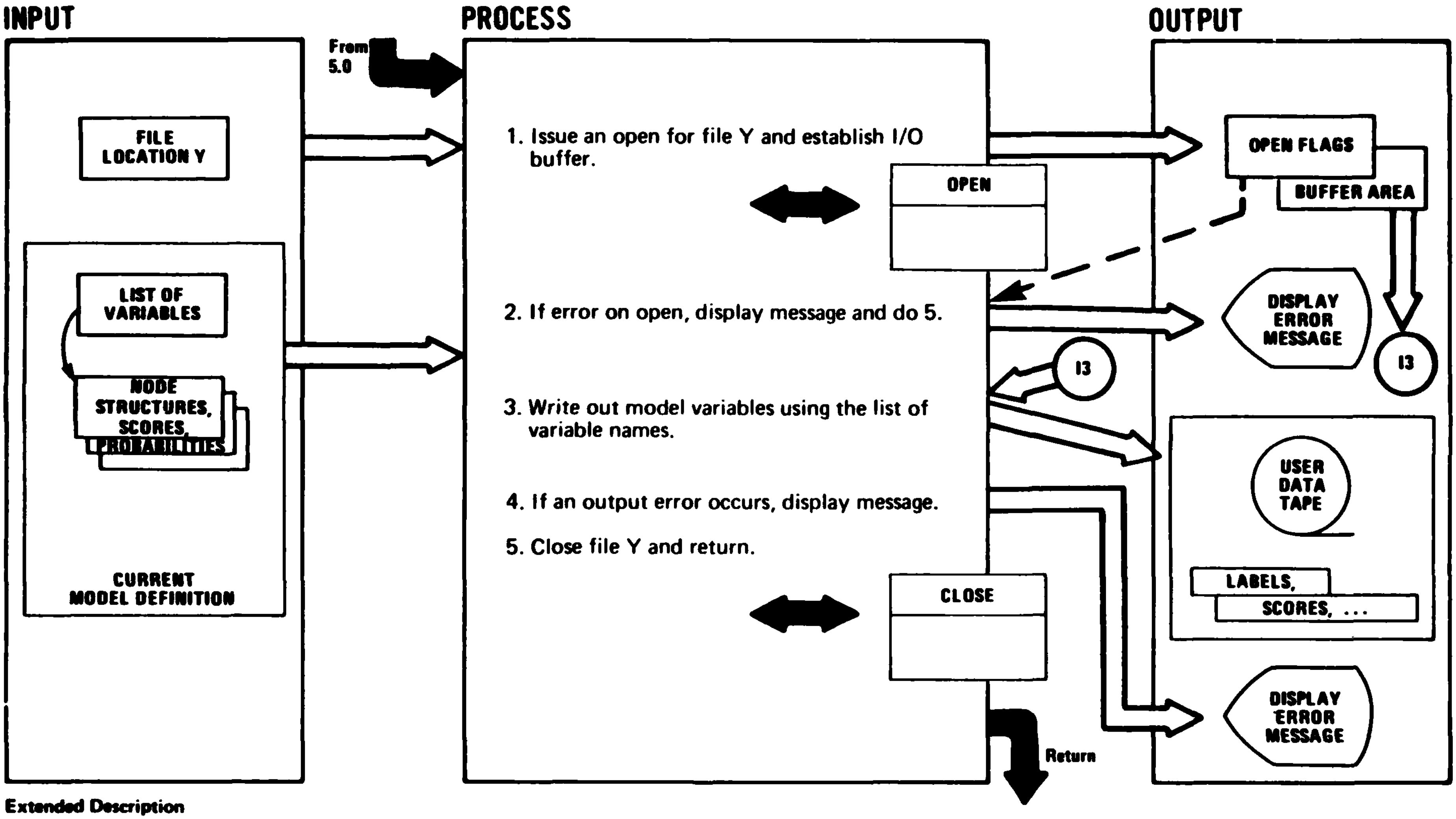
2. If there are no existing models, set Y = 1 and do step 4.

3. Set Y to one plus the number of models currently saved.

4. Return.

System/Program: STRUCTURE Name: DUMPVARS

Diagram ID: 6.2 Description Save the Model Variables Page: ____ of ____



1. Issue an open for file Y and establish I/O buffer.

2. If error on open, display message and do 5.

3. Write out model variables using the list of variable names.

4. If an output error occurs, display message.

5. Close file Y and return.

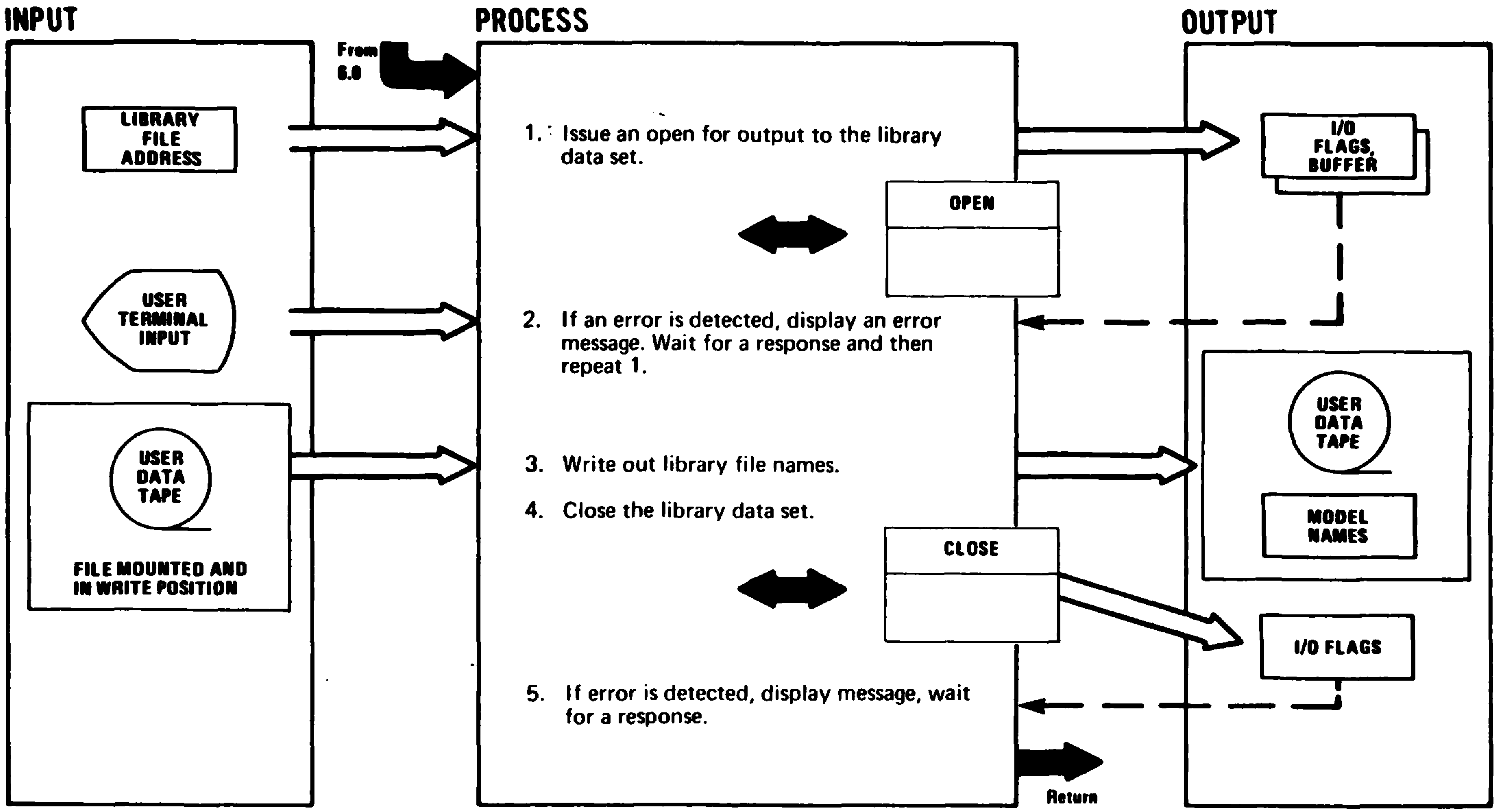
**Extended Description**

1. The file location Y is used to determine an exact storage position on the selected device.

3. The list of variable names is identical to the list of names used to Load a Model (see diagram 2.2)

System Program STRUCTURE Name: SAVELIB

Diagram ID 6.3 Description Save the Library Page: ___ of ___



1. Issue an open for output to the library data set.

2. If an error is detected, display an error message. Wait for a response and then repeat 1.

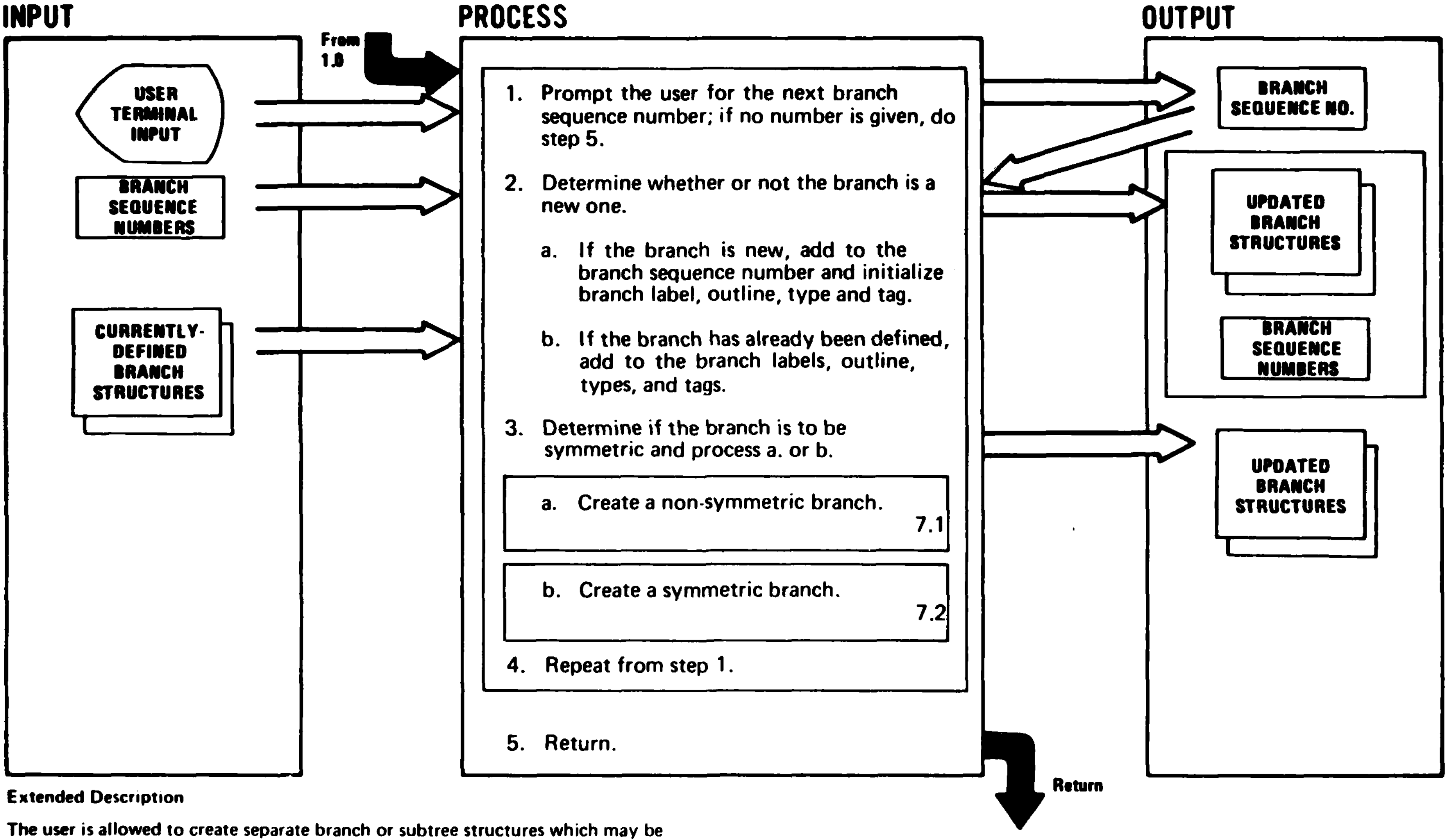
3. Write out library file names.

4. Close the library data set.

5. If error is detected, display message, wait for a response.

System Program STRUCTURE Name

Diagram ID 7.0 Description Create a Branch to the Structure Page ___ of ___



1. Prompt the user for the next branch sequence number; if no number is given, do step 5.

2. Determine whether or not the branch is a new one.

   a. If the branch is new, add to the branch sequence number and initialize branch label, outline, type and tag.

   b. If the branch has already been defined, add to the branch labels, outline, types, and tags.

3. Determine if the branch is to be symmetric and process a. or b.

   a. Create a non-symmetric branch. 7.1

   b. Create a symmetric branch. 7.2

4. Repeat from step 1.

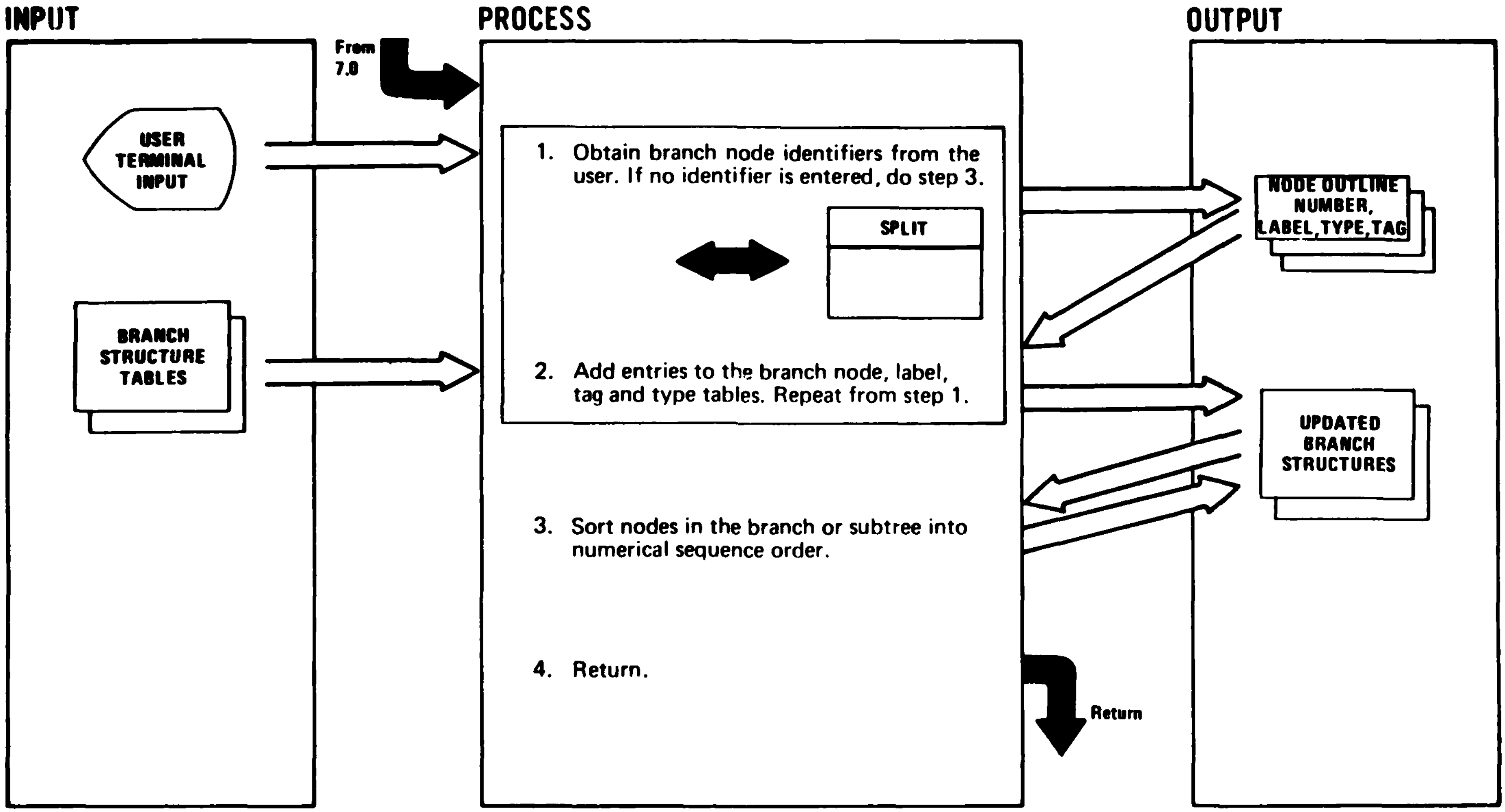
5. Return.

Extended Description

The user is allowed to create separate branch or subtree structures which may be added to the model structure under the "create a structure" process option.

System Program STRUCTURE Name:

Diagram ID 7.1 Description Create a Non-Symmetric Branch Page ___ of ___



1. Obtain branch node identifiers from the user. If no identifier is entered, do step 3.

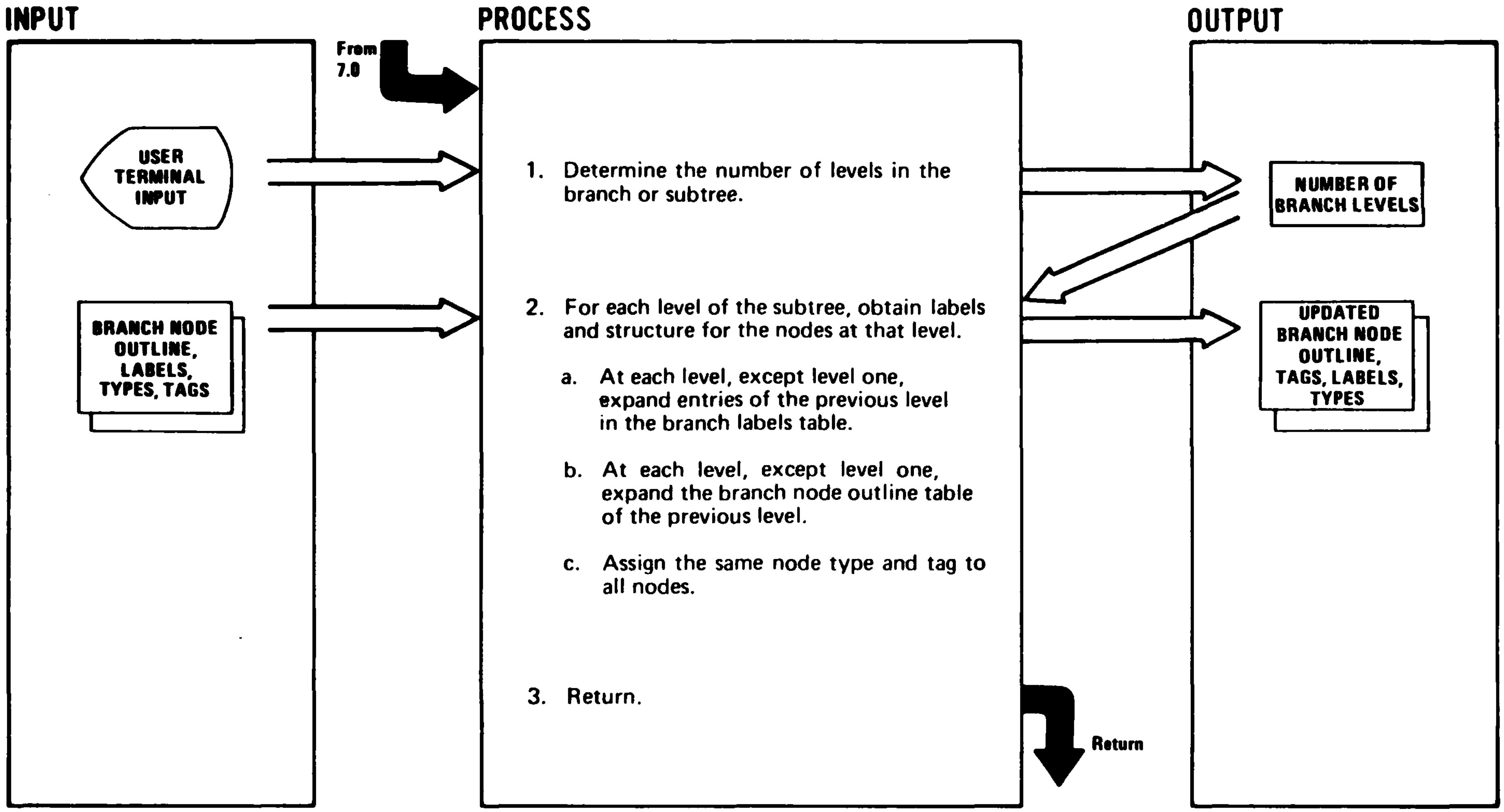
2. Add entries to the branch node, label, tag and type tables. Repeat from step 1.

3. Sort nodes in the branch or subtree into numerical sequence order.

4. Return.

System Program STRUCTURE Name

Diagram ID 7.2 Description Create a Symmetric Branch Page of


INPUT
PROCESS
OUTPUT
From 7.0
USER TERMINAL INPUT
BRANCH NODE OUTLINE, LABELS, TYPES, TAGS
NUMBER OF BRANCH LEVELS
UPDATED BRANCH NODE OUTLINE, TAGS, LABELS, TYPES
Return

1. Determine the number of levels in the branch or subtree.

2. For each level of the subtree, obtain labels and structure for the nodes at that level.

   a. At each level, except level one, expand entries of the previous level in the branch labels table.

   b. At each level, except level one, expand the branch node outline table of the previous level.

   c. Assign the same node type and tag to all nodes.

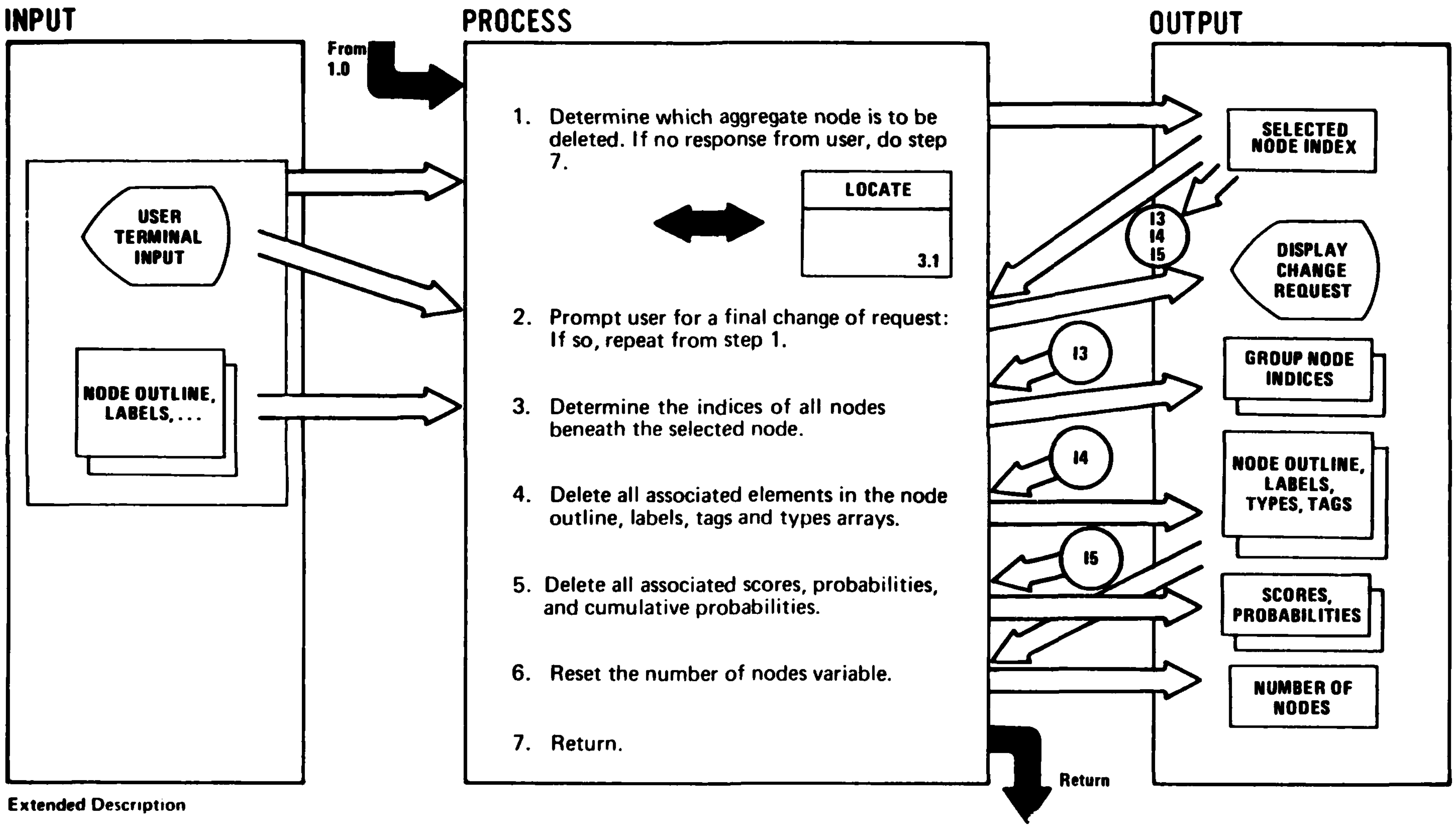
3. Return.

**Extended Description**

Step 2 processing ensures that for each subsequent level of a multilevel branch structure the outline number, types and labels are all added in the correct numerical sequence to the outline, types, tags and label entries at the previous level. (This is done for every branch node defined at the previous level.)

System Program STRUCTURE Name

Diagram ID 8.0 Description Prune a Structure Section Page of



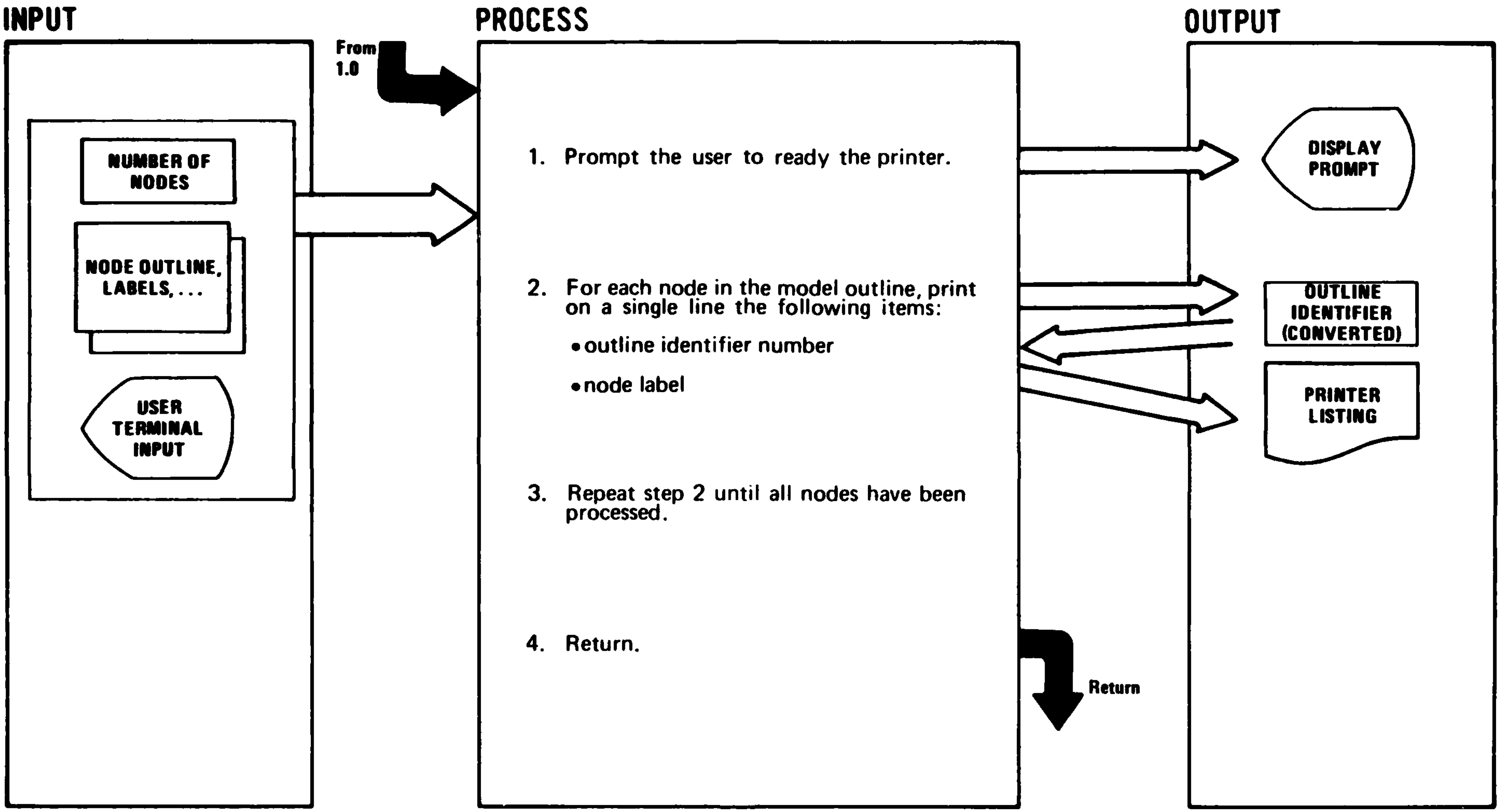
1. Determine which aggregate node is to be deleted. If no response from user, do step 7.
2. Prompt user for a final change of request: If so, repeat from step 1.
3. Determine the indices of all nodes beneath the selected node.
4. Delete all associated elements in the node outline, labels, tags and types arrays.
5. Delete all associated scores, probabilities, and cumulative probabilities.
6. Reset the number of nodes variable.
7. Return.

**Extended Description**

The routine should be executed whenever a group of nodes is to be deleted from an existing node structure. The grouped nodes are all hierarchically placed below a certain aggregate node; hence, a user specification of an aggregate node in step 1 will cause that node and all its subsequent nodes to be deleted.

System Program STRUCTURE Name:

Diagram ID: 9.0 Description Print a Review Sheet Page: of



1. Prompt the user to ready the printer.

2. For each node in the model outline, print on a single line the following items:

   - outline identifier number

   - node label

3. Repeat step 2 until all nodes have been processed.

4. Return.

**Extended Description**

2. The decoded outline identifier number is formatted for output. The output should be equivalent to the user's original input during the creation of the structure.

System/Program: STRUCTURE Name: ________

Diagram ID: 10.0 Description General Routines Page: ____ of ____

INPUT

PROCESS

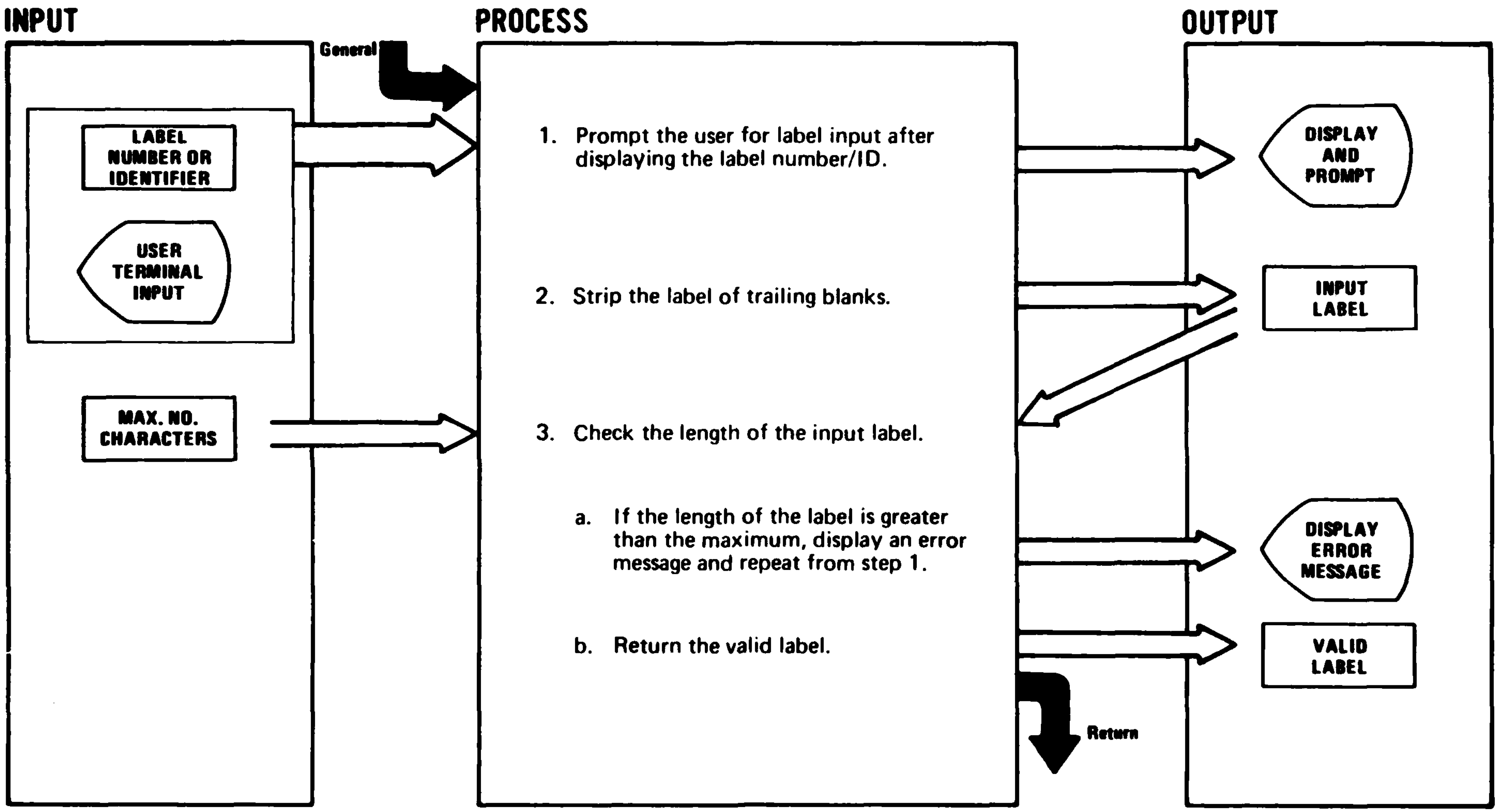
OUTPUT

**Extended Description**

Generalized routines are directly invoked by functional procedures and return to the calling programs.

System/Program: STRUCTURE Name: ENTER LABELS

Diagram ID: 10.1 Description Enter Labels Routine Page: ___ of ___



1. Prompt the user for label input after displaying the label number/ID.

2. Strip the label of trailing blanks.

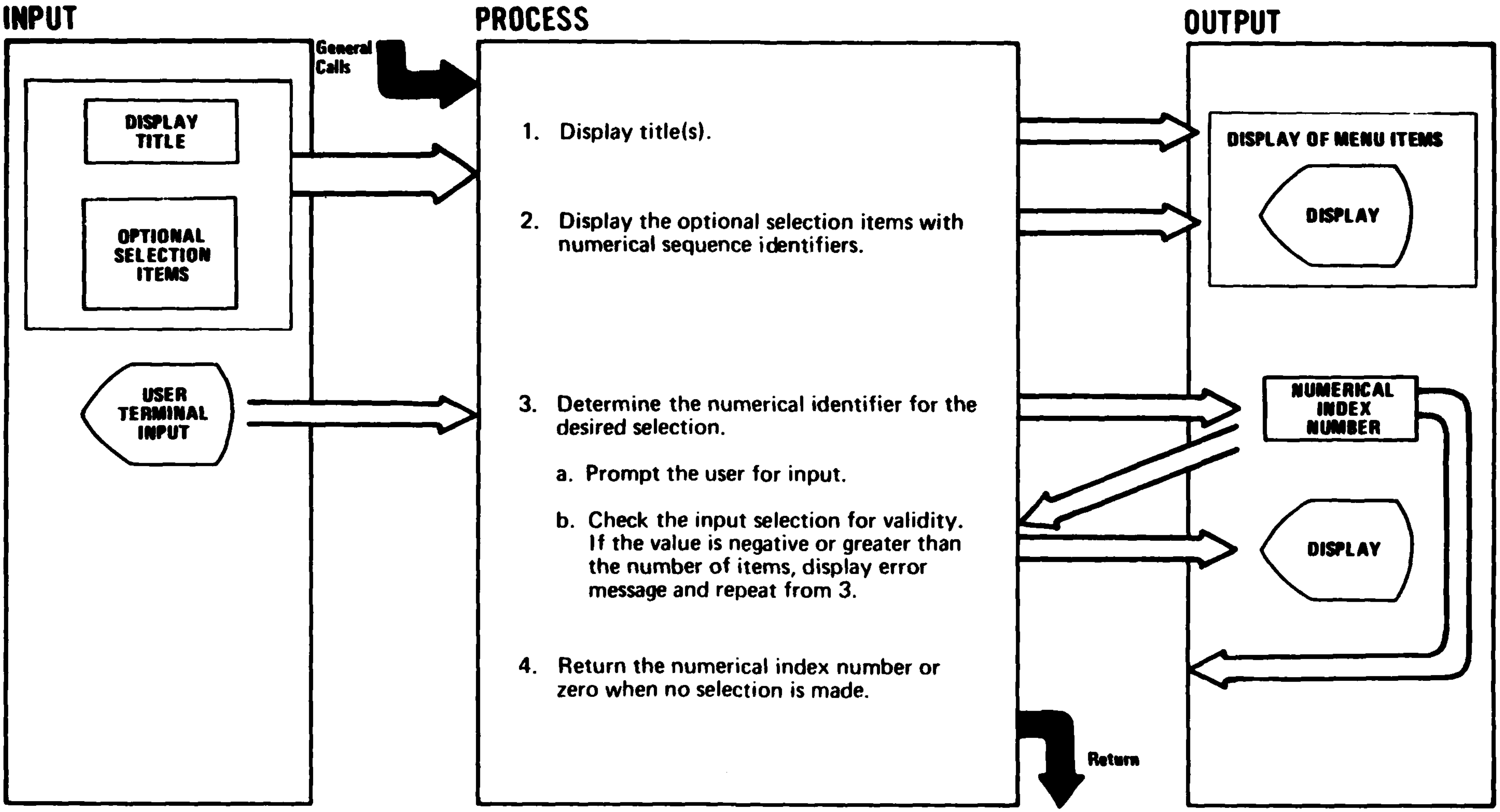
3. Check the length of the input label.

   a. If the length of the label is greater than the maximum, display an error message and repeat from step 1.

   b. Return the valid label.

System/Program: STRUCTURE Name: MENU

Diagram ID: 10.2 Description Display a Menu Page: ___ of ___



1. Display title(s).

2. Display the optional selection items with numerical sequence identifiers.

3. Determine the numerical identifier for the desired selection.

   a. Prompt the user for input.

   b. Check the input selection for validity. If the value is negative or greater than the number of items, display error message and repeat from 3.

4. Return the numerical index number or zero when no selection is made.

Extended Description

1. The title is passed to this routine so that the display will remain in context with the processing function. For example, a title may be 'DISPLAY RESULTS.'

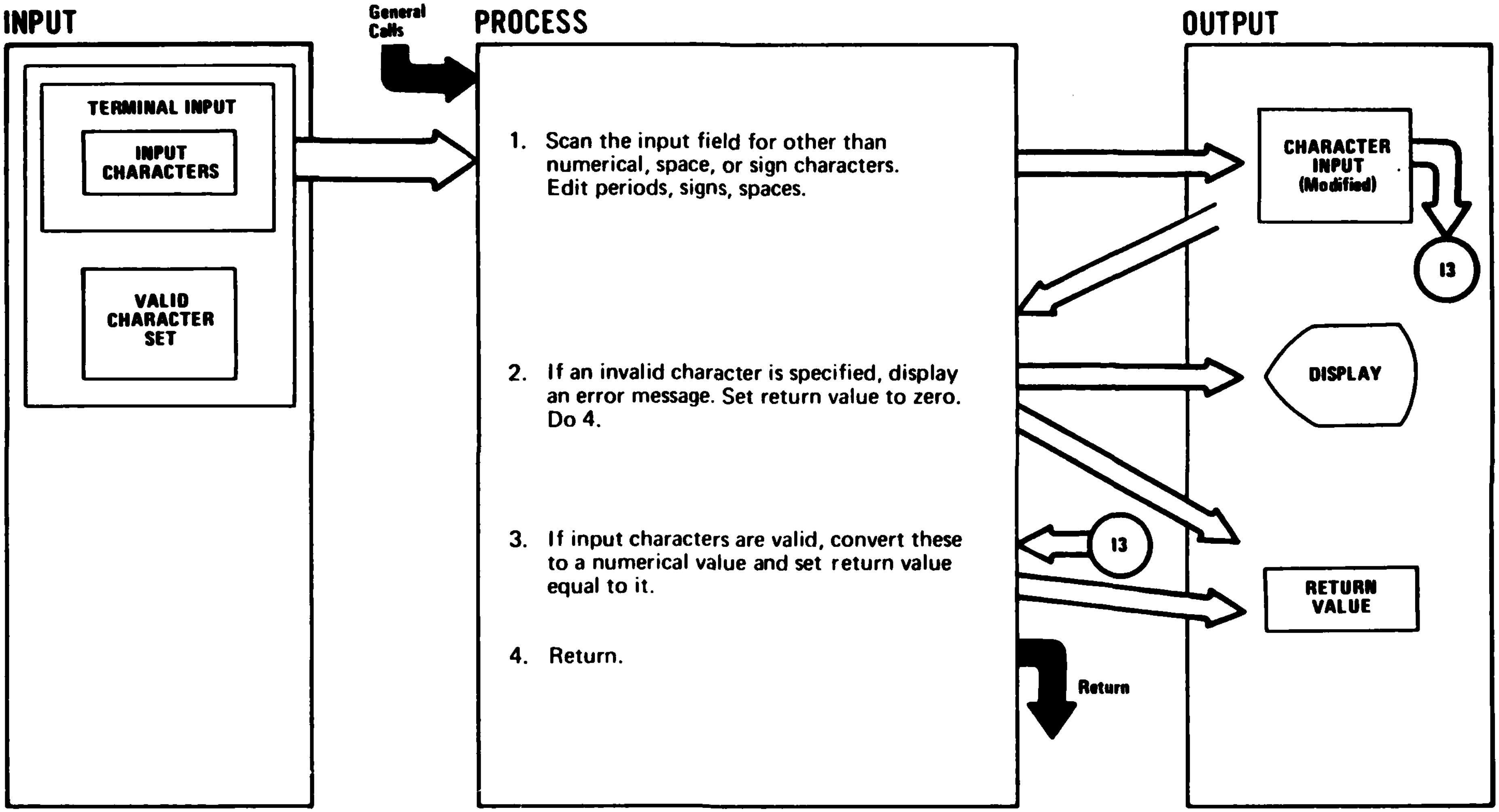
2. The selections that describe what is optimal are passed as input and are displayed in a list or cookbook MENU format along with item sequence numbers.

3. Prompt the user for the item sequence number of the choice selection.

Check the validity of the user input.

System/Program: STRUCTURE Name

Diagram ID 10.3 Description Select Only Numeric Input Page: of



1. Scan the input field for other than numerical, space, or sign characters. Edit periods, signs, spaces.

2. If an invalid character is specified, display an error message. Set return value to zero. Do 4.

3. If input characters are valid, convert these to a numerical value and set return value equal to it.

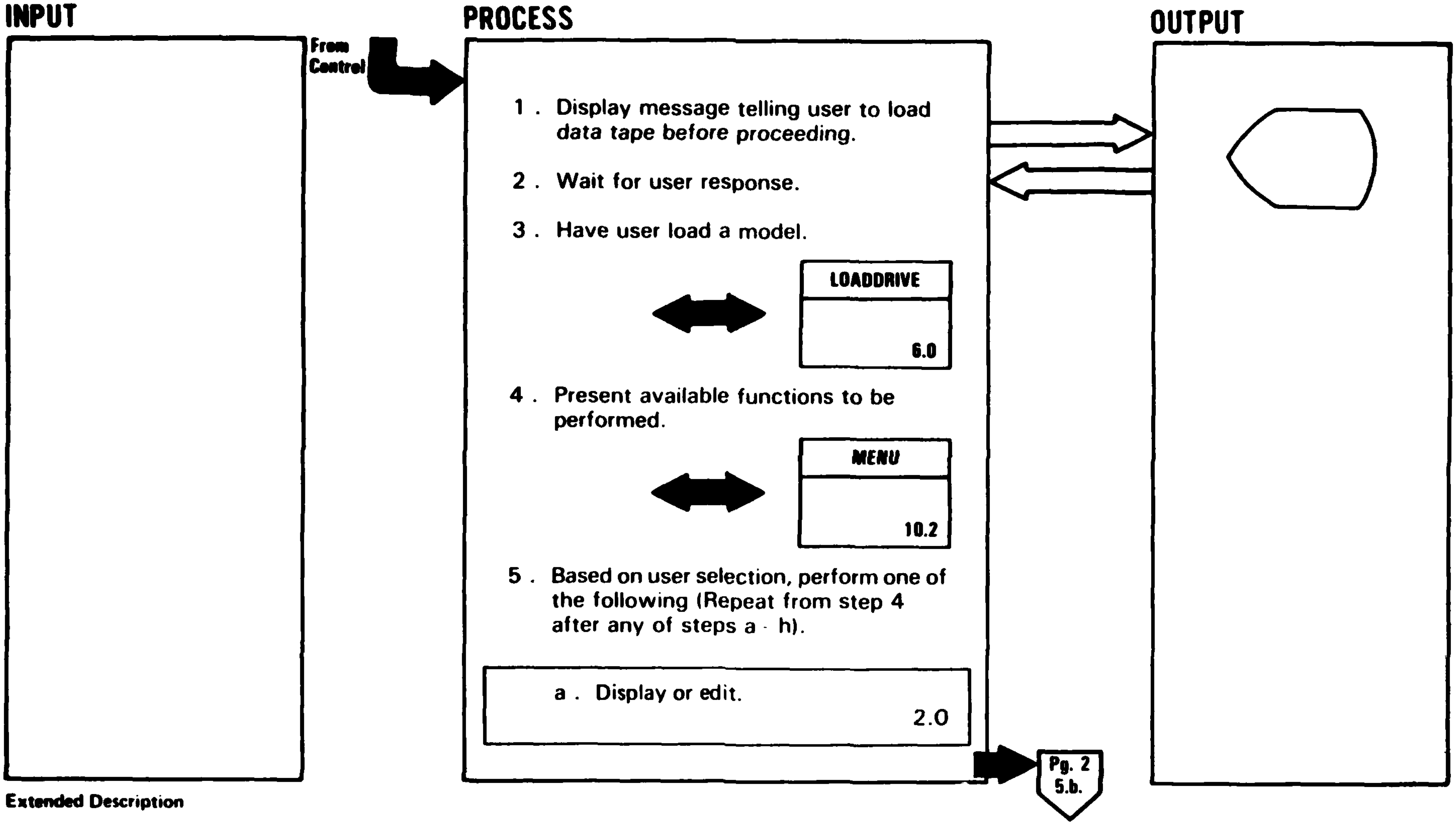
4. Return.

**Extended Description**

This routine will not be required if system error checking routines interface with the standard keyboard display input.

System/Program: RUN Name: RUN

Diagram ID: 1.0 Description: Entrance to Run Program Page: 1 of 2



INPUT

PROCESS

OUTPUT

From Control

1 . Display message telling user to load data tape before proceeding.

2 . Wait for user response.

3 . Have user load a model.

LOADDRIVE 6.0

4 . Present available functions to be performed.

MENU 10.2

5 . Based on user selection, perform one of the following (Repeat from step 4 after any of steps a - h).

a . Display or edit. 2.0

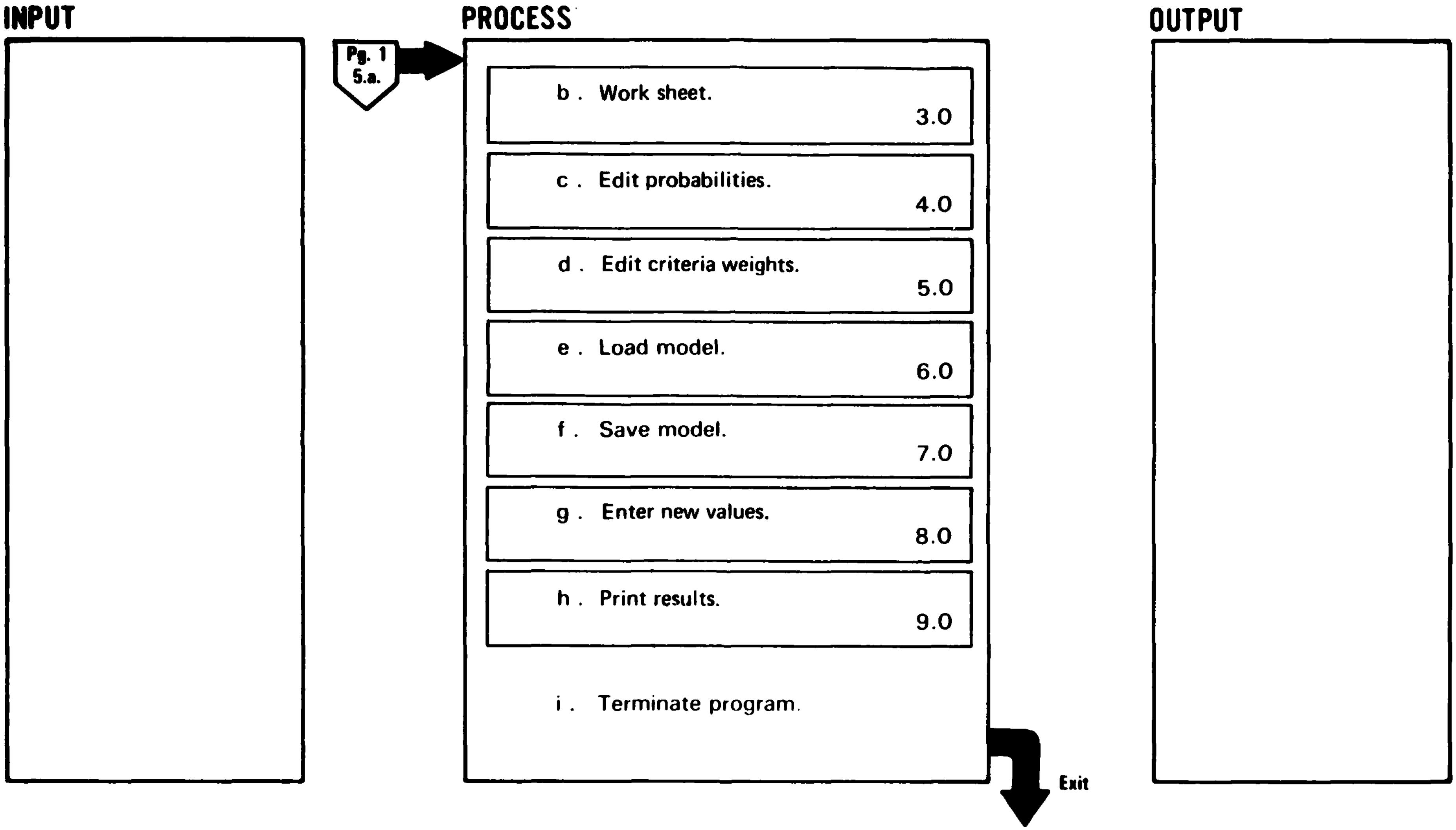
Pg. 2 5.b.

**Extended Description**

3. *The model variables are all loaded into the current work area at this time, or whenever the user wishes to load a new model. Consequently, this documentation assumes that these variables are "global" and always available for input to procedures, reference, or modification by subroutines.*

System Program: RUN Name: RUN

Diagram ID: 1.0 Description Entrance to Run Program Page 2 of 2



b . Work sheet. 3.0

c . Edit probabilities. 4.0

d . Edit criteria weights. 5.0

e . Load model. 6.0

f . Save model. 7.0

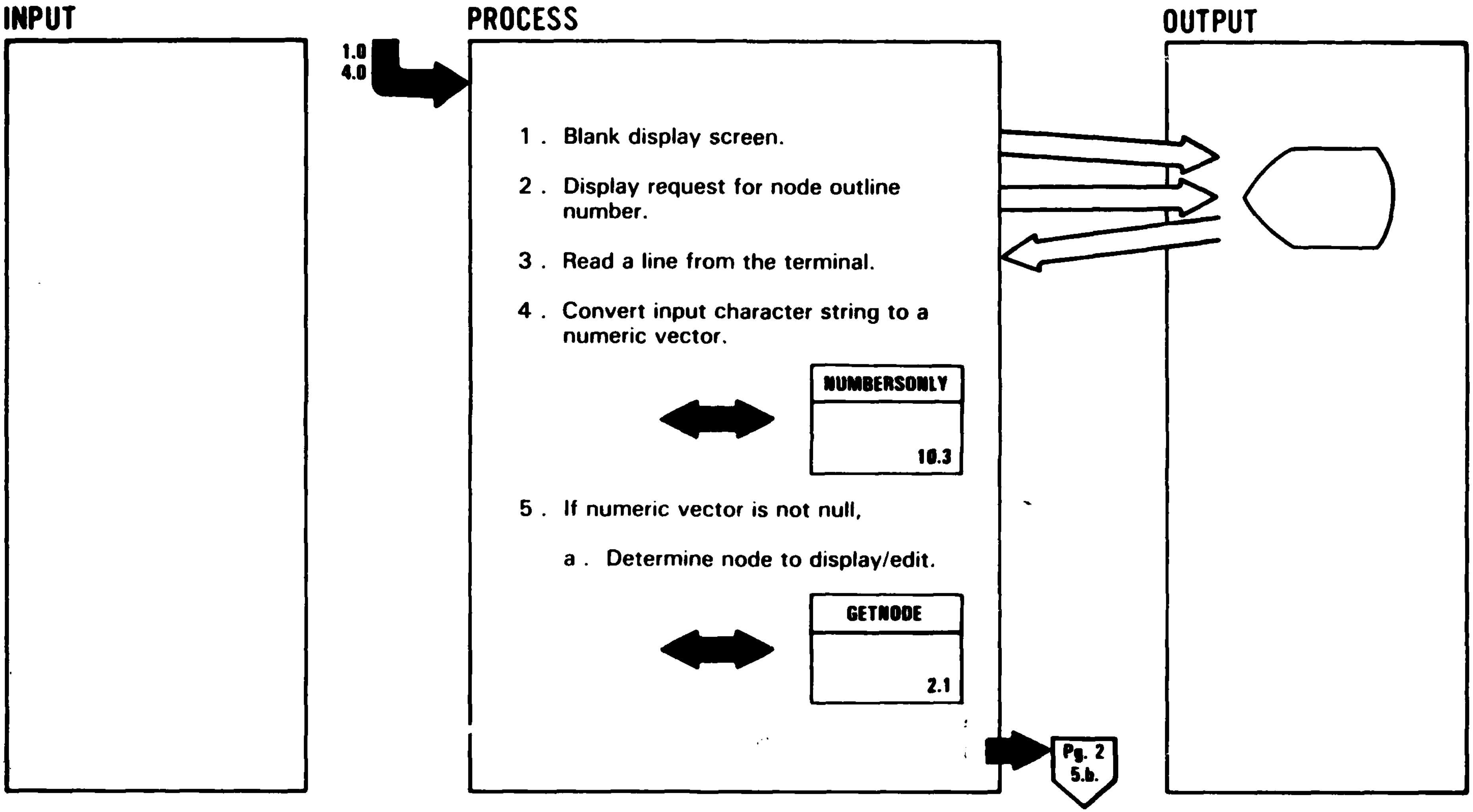
g . Enter new values. 8.0

h . Print results. 9.0

i . Terminate program.

System Program RUN Name SELECT

Diagram ID 2.0 Description Display or Edit Page 1 of 2



INPUT

PROCESS

OUTPUT

1 . Blank display screen.

2 . Display request for node outline number.

3 . Read a line from the terminal.

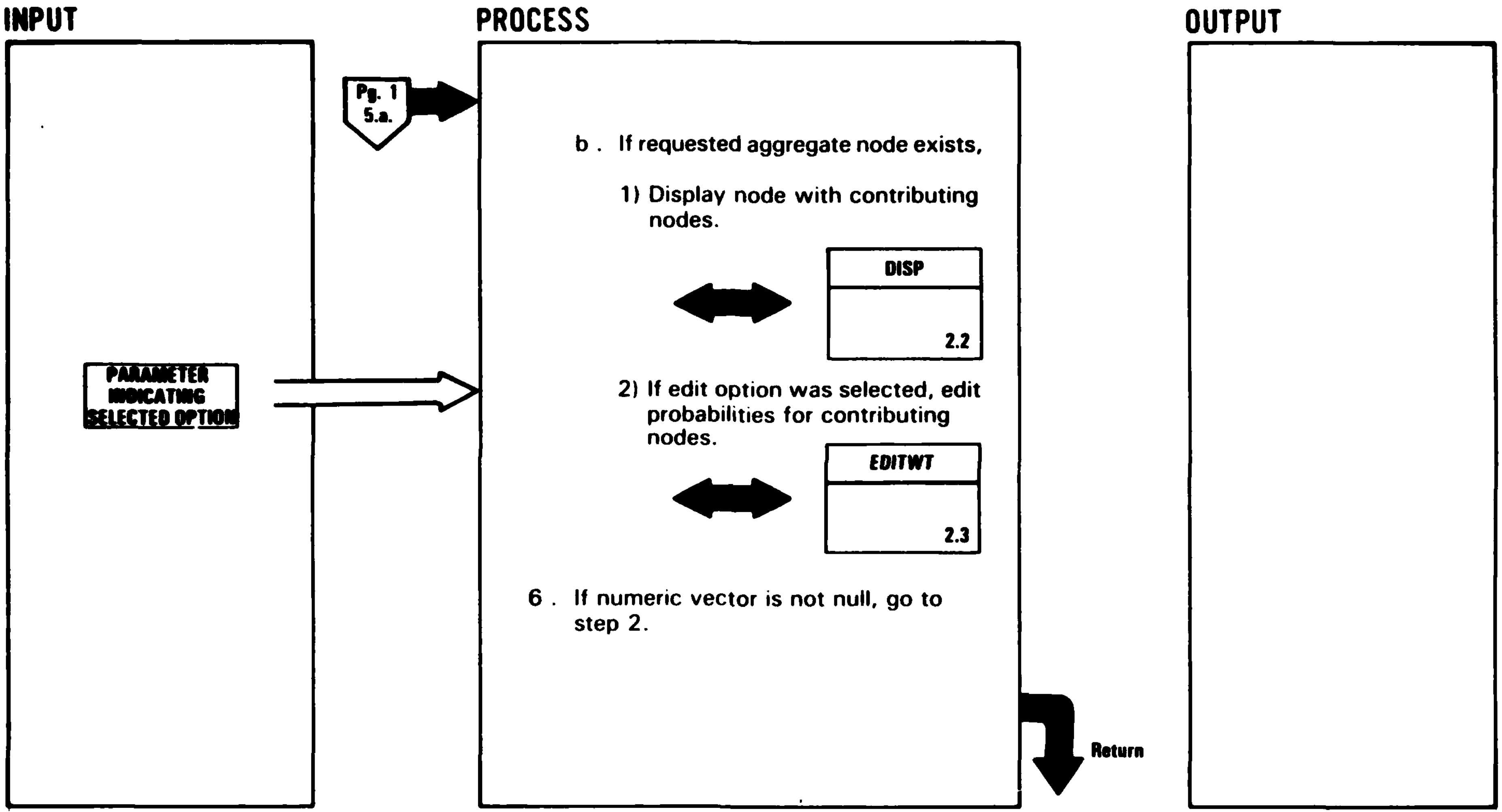
4 . Convert input character string to a numeric vector.

5 . If numeric vector is not null,

a . Determine node to display/edit.

System Program RUN Name SELECT

Diagram ID 2.0 Description Display or Edit Page 2 of 2



INPUT

PARAMETER INDICATING SELECTED OPTION

PROCESS

b . If requested aggregate node exists,

1) Display node with contributing nodes.

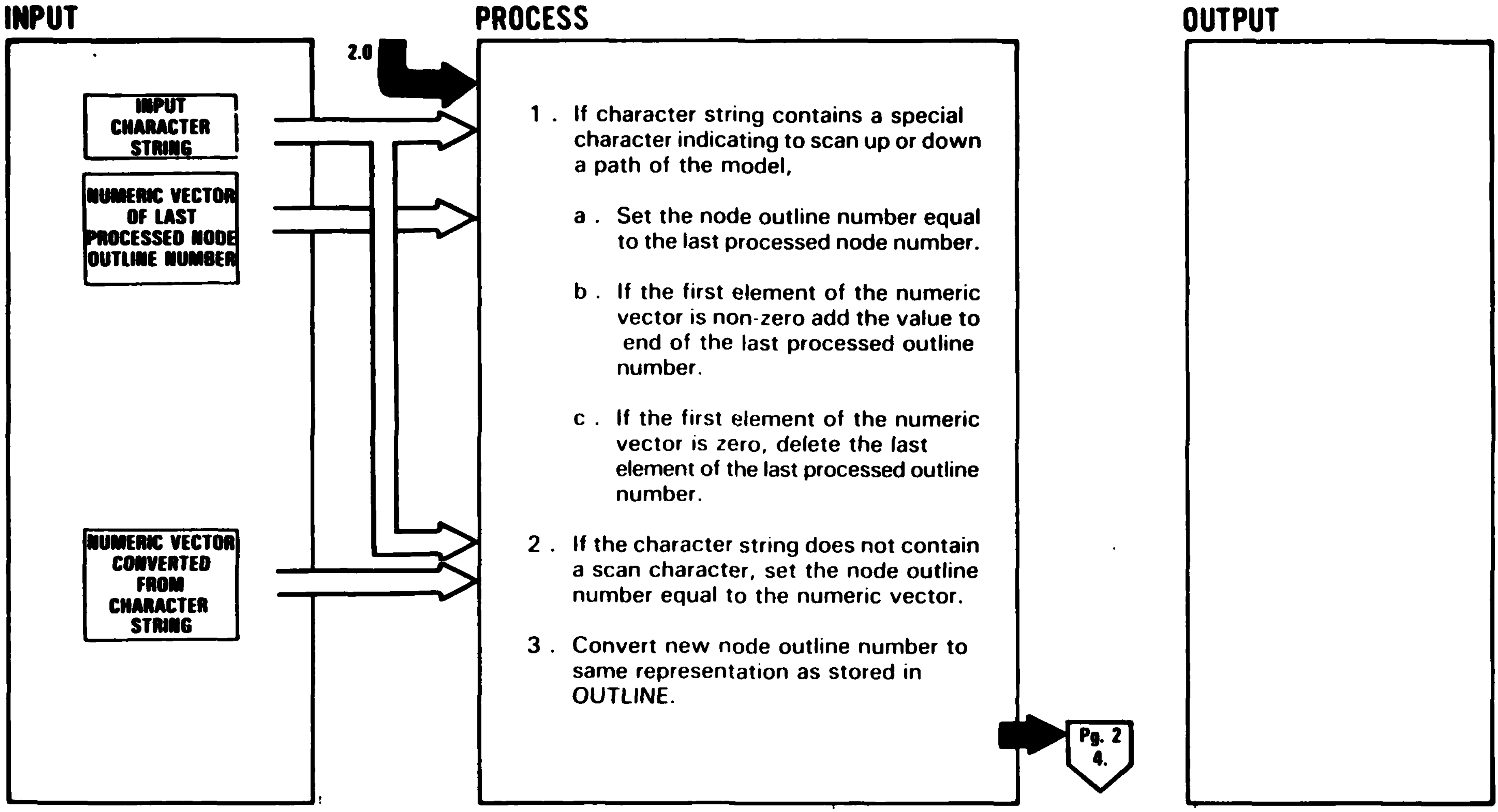
2) If edit option was selected, edit probabilities for contributing nodes.

6 . If numeric vector is not null, go to step 2.

OUTPUT

System/Program: RUN Name: GETNODE

Diagram ID: 2.1 Description: Determine Node to Display Page: 1 of 2



INPUT

INPUT CHARACTER STRING
NUMERIC VECTOR OF LAST PROCESSED NODE OUTLINE NUMBER
NUMERIC VECTOR CONVERTED FROM CHARACTER STRING
2.0

PROCESS

1 . If character string contains a special character indicating to scan up or down a path of the model,

a . Set the node outline number equal to the last processed node number.

b . If the first element of the numeric vector is non-zero add the value to end of the last processed outline number.

c . If the first element of the numeric vector is zero, delete the last element of the last processed outline number.

2 . If the character string does not contain a scan character, set the node outline number equal to the numeric vector.

3 . Convert new node outline number to same representation as stored in OUTLINE.

OUTPUT

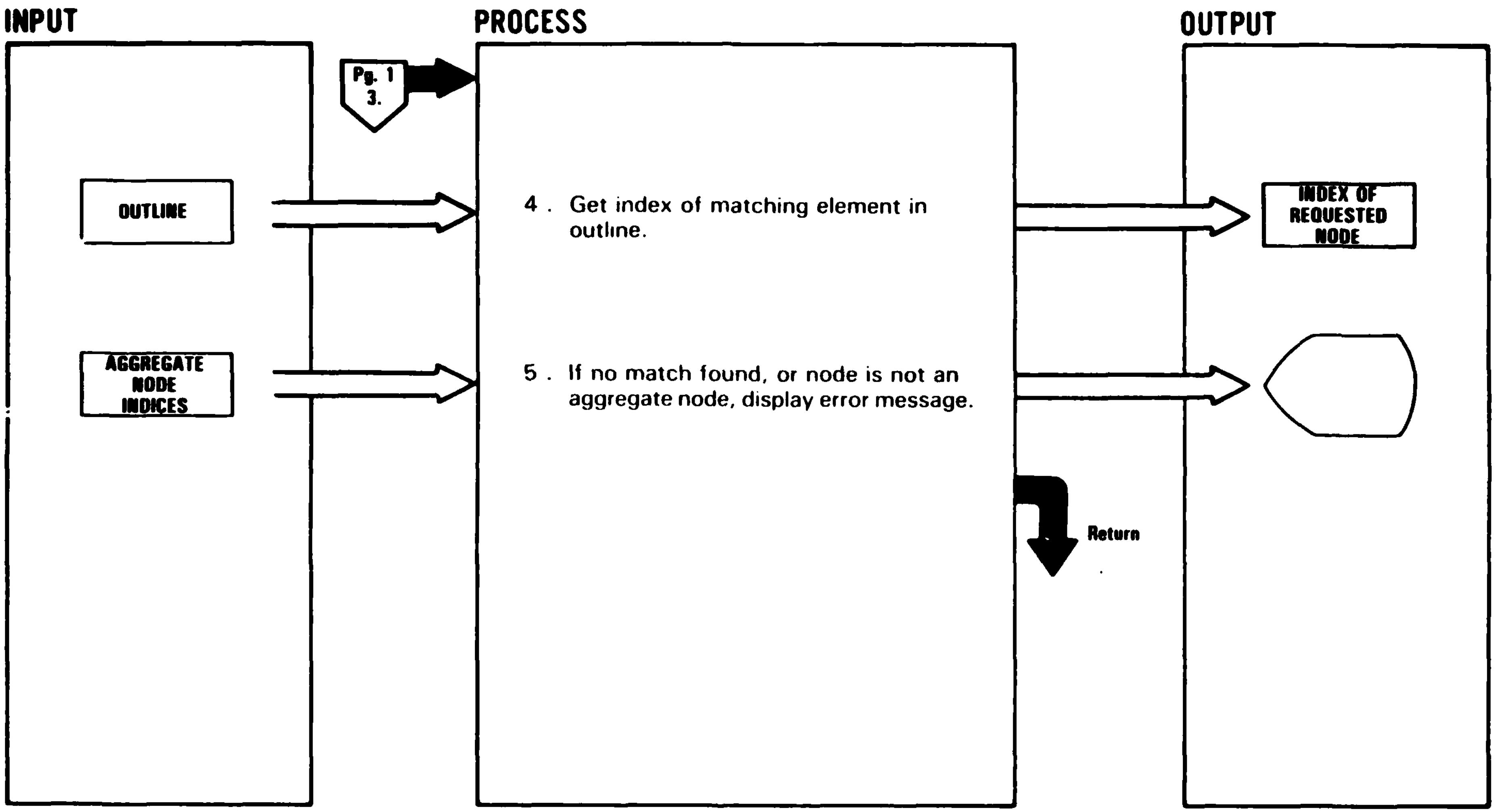
**Extended Description**

b. This generates a node outline number one level deeper than the previously processed node. For example, if the previously processed number were 3.2.5 and the input '6)' (where the right parenthesis is the scan operator) the new node outline number would be 3.2.5.6.

c. This generates a node outline number one level higher than the previously processed node. For example, if the previously processed number were 3.2.5 and the input zero followed by the right parenthesis scan operator, the new node outline number would be 3.2.

System/Program: RUN Name GETNODE

Diagram ID: 2.1 Description Determine Node to Display Page 2 of 2

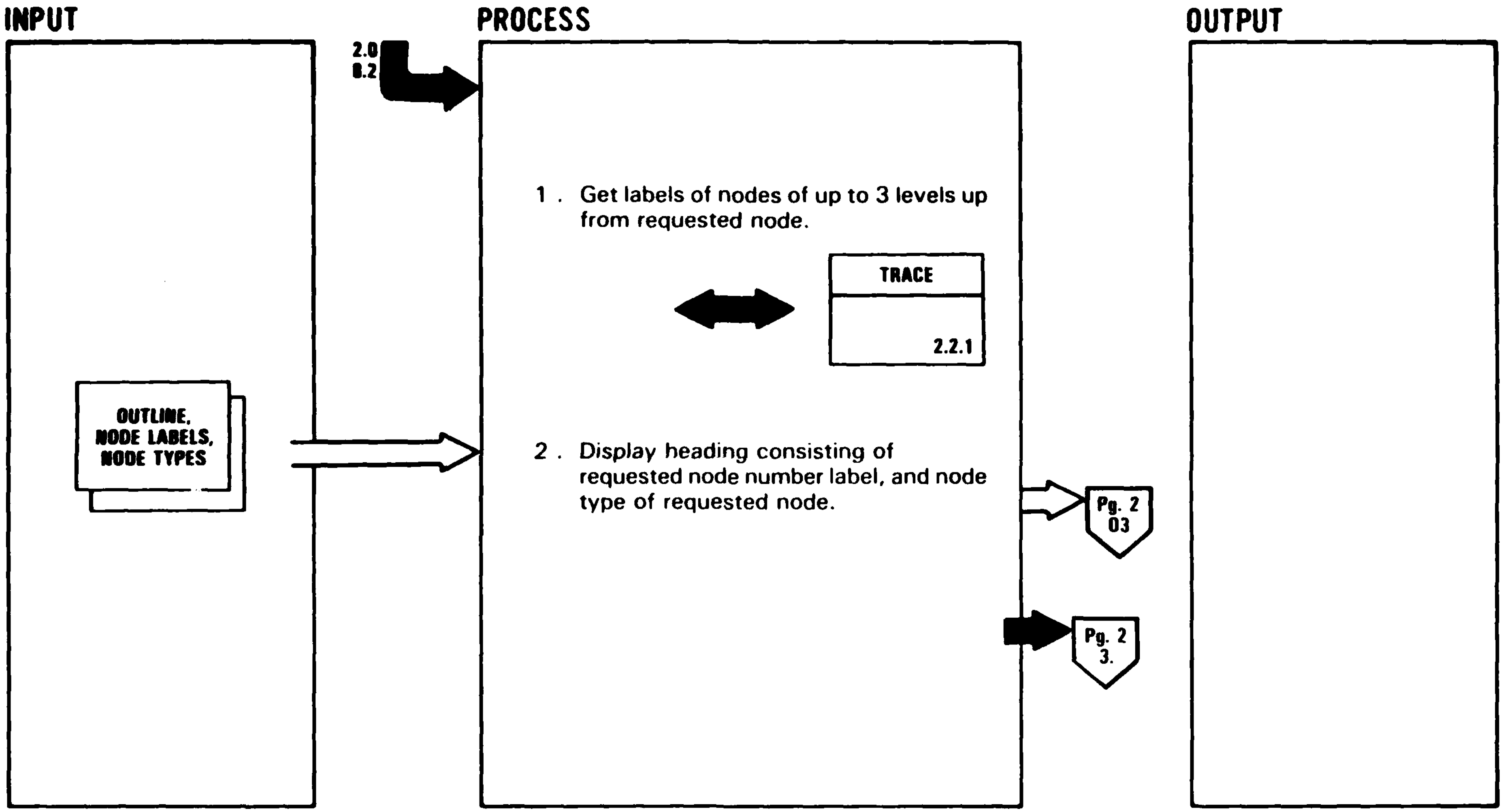


4 . Get index of matching element in outline.

5 . If no match found, or node is not an aggregate node, display error message.

System Program RUN Name DISP

Diagram ID 2.2 Description Display Group Page 1 of 2

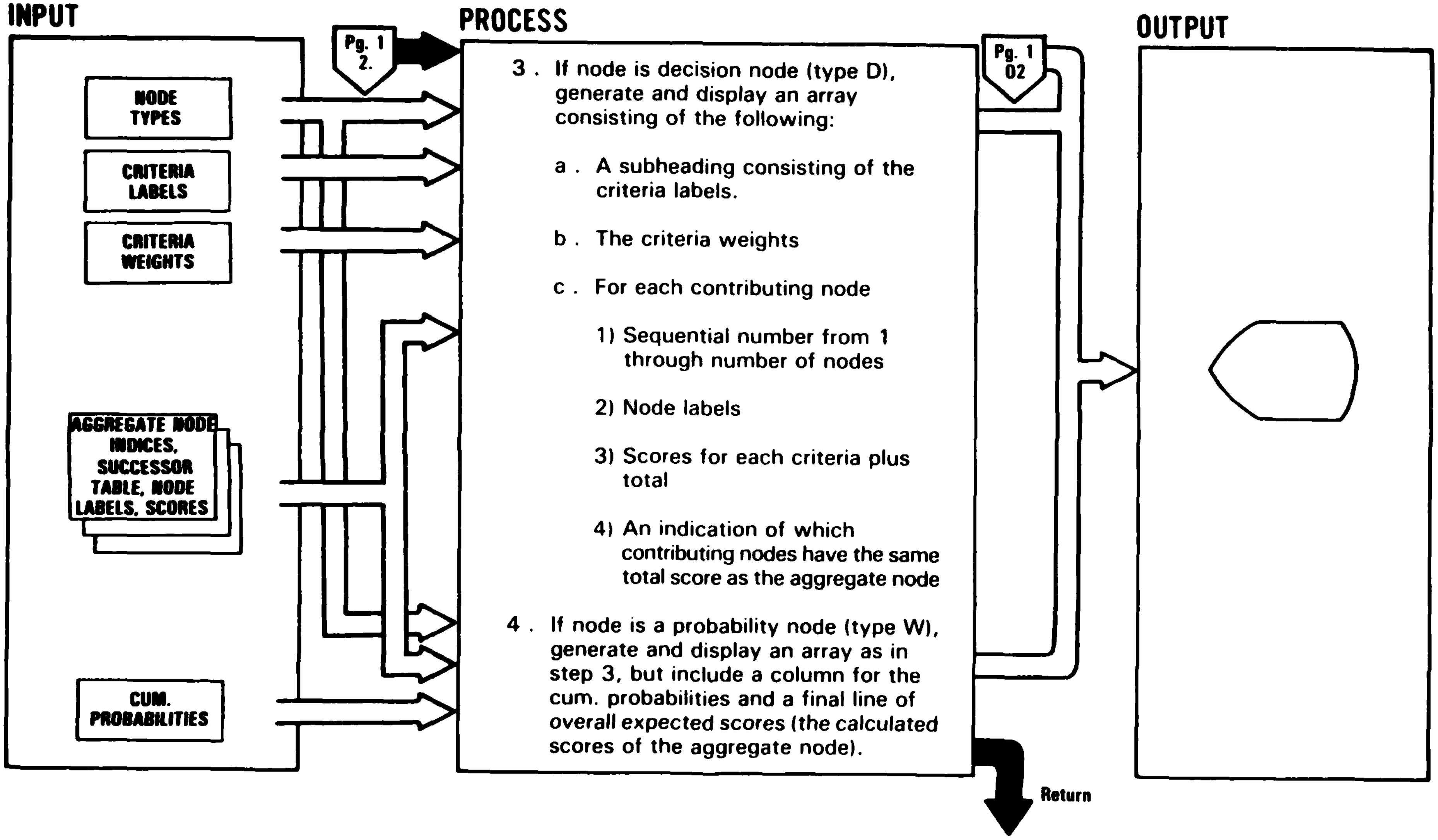


1 . Get labels of nodes of up to 3 levels up from requested node.

2 . Display heading consisting of requested node number label, and node type of requested node.

System/Program: RUN  Name: DISP

Diagram ID: 2.2  Description: Diplay Group  Page: 2 of 2



3 . If node is decision node (type D), generate and display an array consisting of the following:

a . A subheading consisting of the criteria labels.

b . The criteria weights

c . For each contributing node

1) Sequential number from 1 through number of nodes

2) Node labels

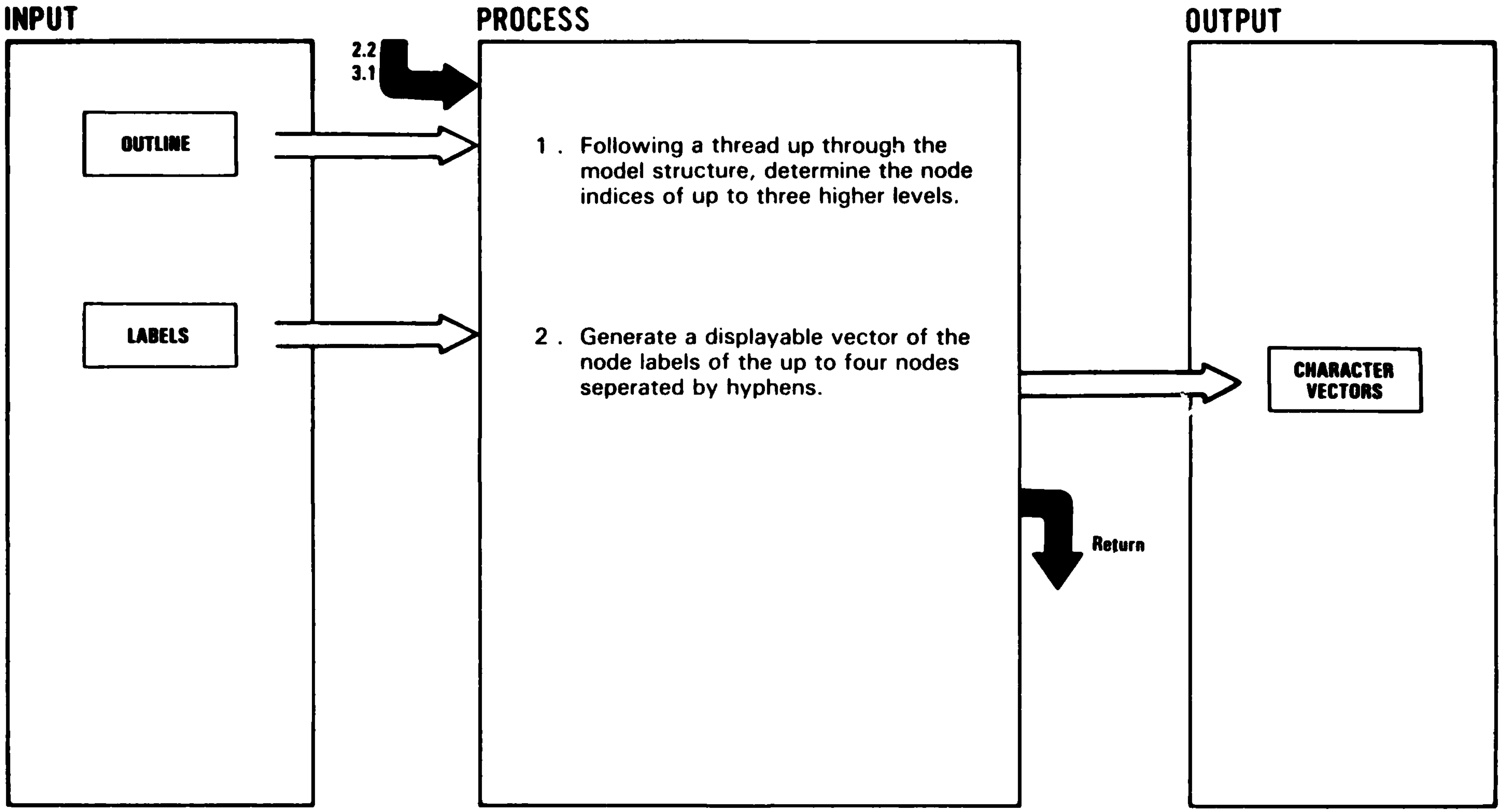
3) Scores for each criteria plus total

4) An indication of which contributing nodes have the same total score as the aggregate node

4 . If node is a probability node (type W), generate and display an array as in step 3, but include a column for the cum. probabilities and a final line of overall expected scores (the calculated scores of the aggregate node).

System Program: RUN　　Name: TRACE

Diagram ID: 2.2.1　　Description: Get Nodes of Thread　　Page: ____ of ____



INPUT

OUTLINE

LABELS

2.2
3.1

PROCESS

1 . Following a thread up through the model structure, determine the node indices of up to three higher levels.

2 . Generate a displayable vector of the node labels of the up to four nodes seperated by hyphens.

Return

OUTPUT

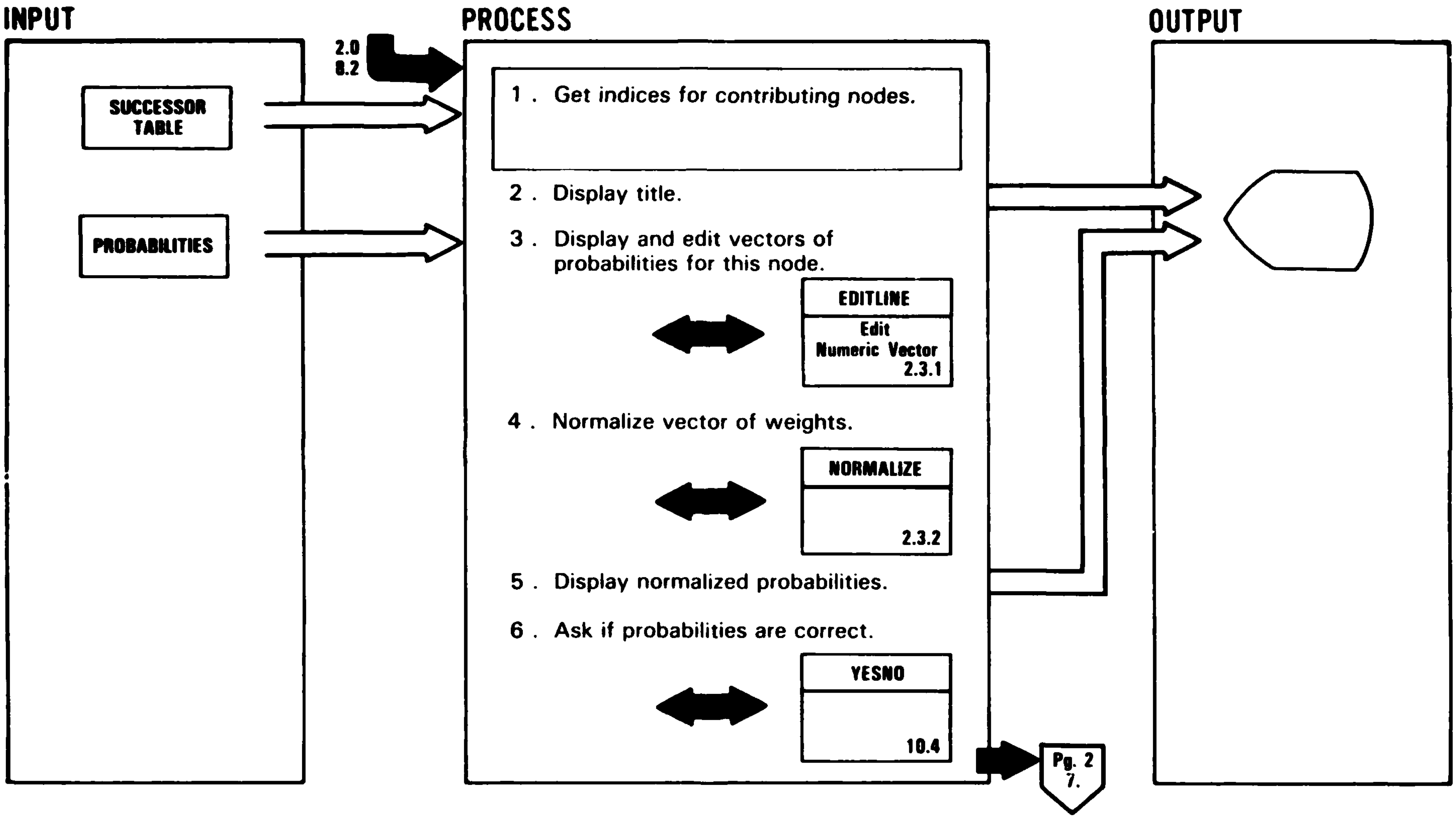
CHARACTER VECTORS

**Extended Description**

For instance, if the requested node number is 1.4.2.2.6, the next higher level would be 1.4.2.2, the next higher would be 1.4.2, and the fourth (or highest) calculated level would be 1.4.

System Program RUN Name EDITWT

Diagram ID 2.3 Description Edit Probabilities Page: 1 of 2



INPUT

PROCESS

OUTPUT

1 . Get indices for contributing nodes.

2 . Display title.

3 . Display and edit vectors of probabilities for this node.

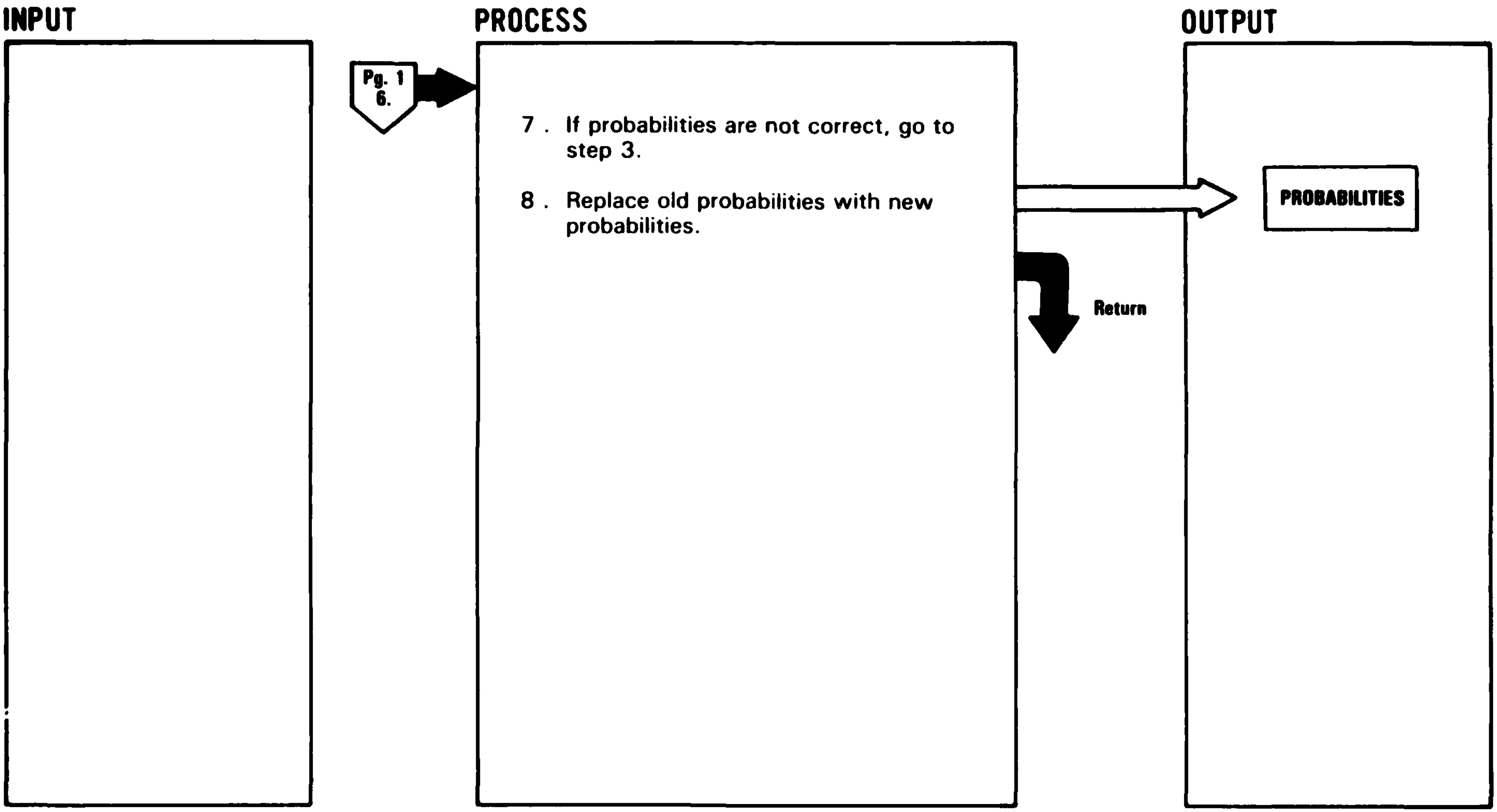
4 . Normalize vector of weights.

5 . Display normalized probabilities.

6 . Ask if probabilities are correct.

System Program: RUN Name: EDITWT

Diagram ID: 2.3 Description: Edit Probabilities Page 2 of 2

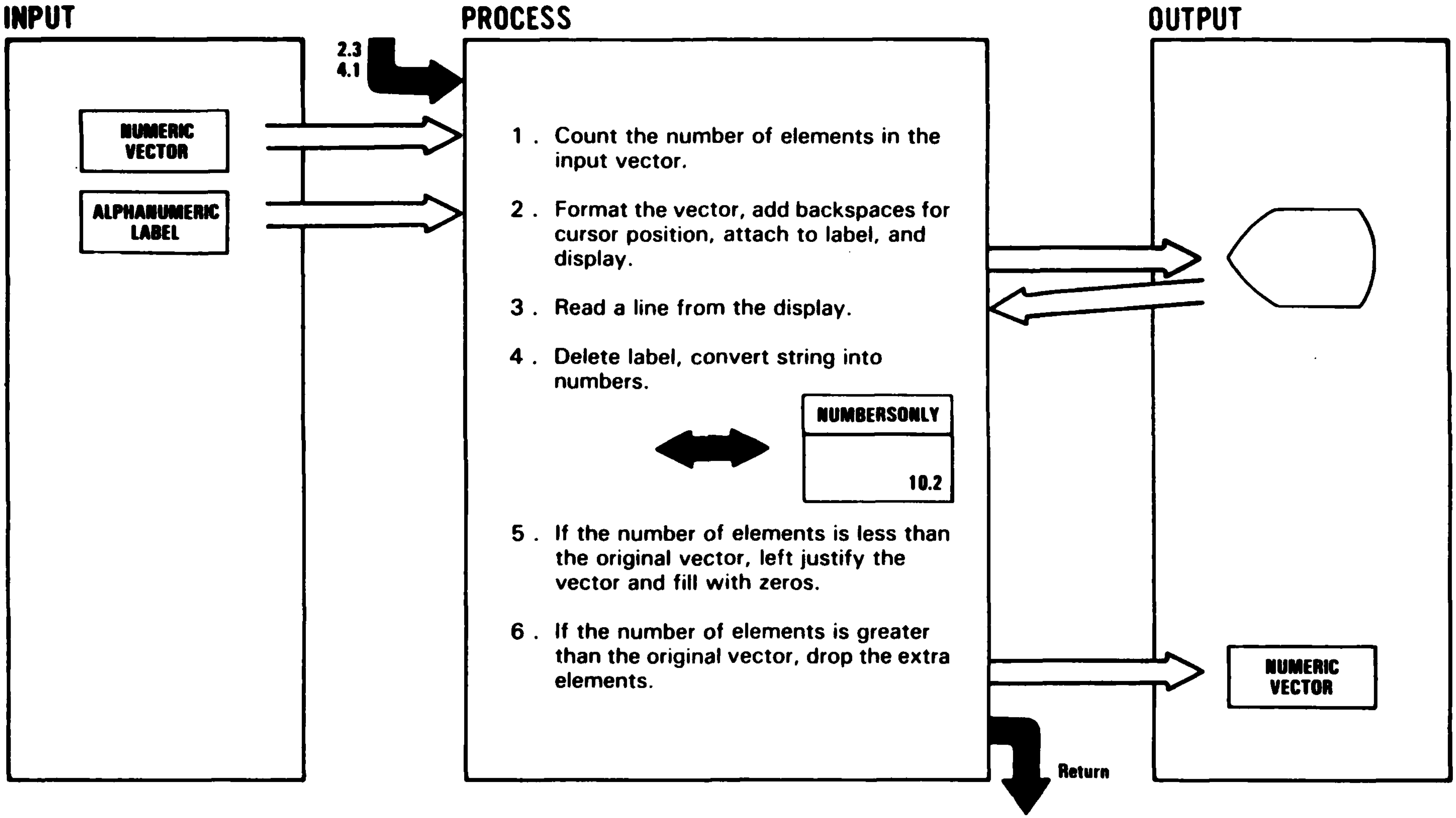


7 . If probabilities are not correct, go to step 3.

8 . Replace old probabilities with new probabilities.

System/Program RUN Name EDITLINE

Diagram ID 2.3.1 Description Edit a Numeric Vector Page ____ of ____



1 . Count the number of elements in the input vector.

2 . Format the vector, add backspaces for cursor position, attach to label, and display.

3 . Read a line from the display.

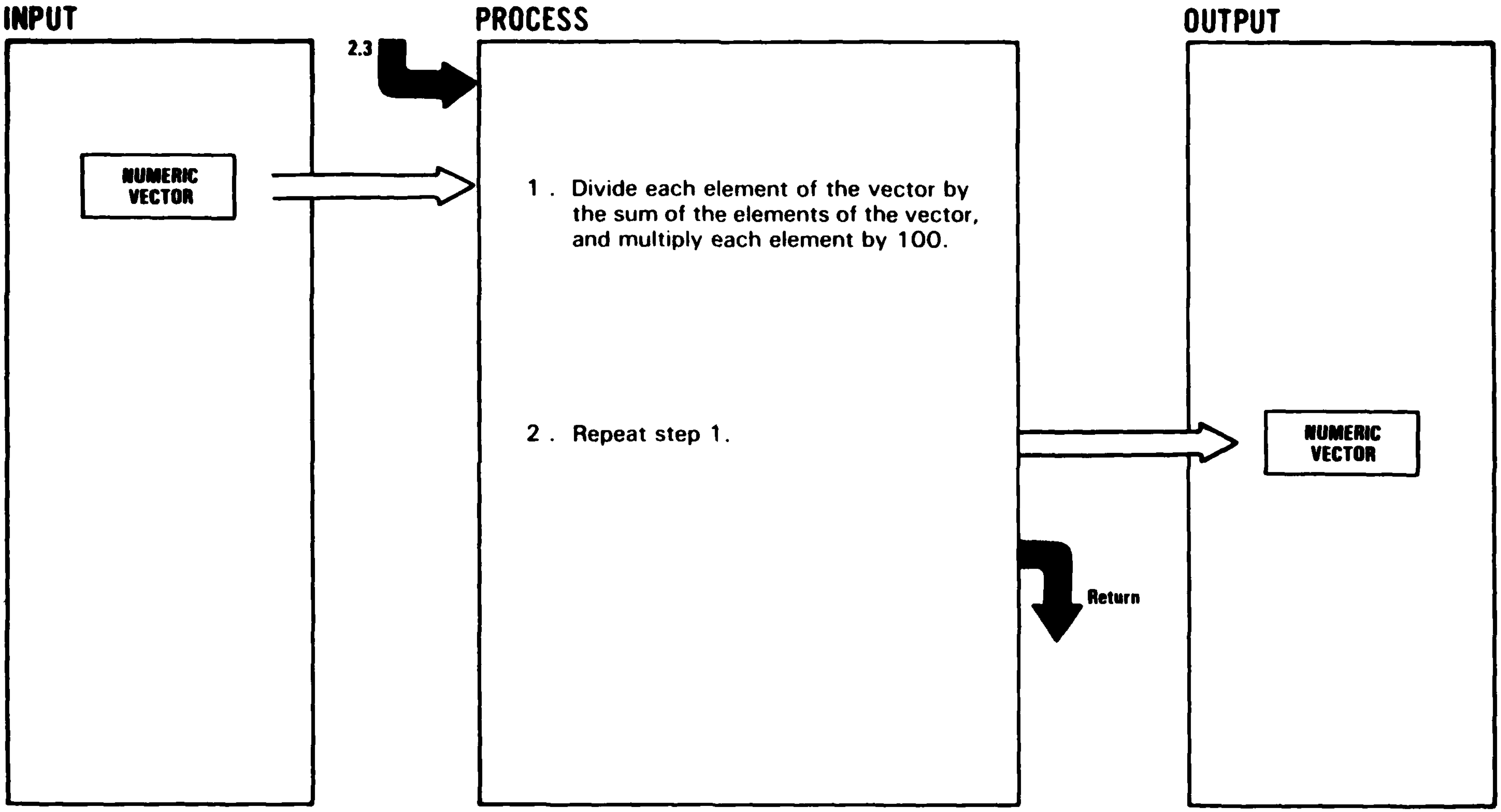
4 . Delete label, convert string into numbers.

5 . If the number of elements is less than the original vector, left justify the vector and fill with zeros.

6 . If the number of elements is greater than the original vector, drop the extra elements.

System Program RUN Name NORMALIZE

Diagram ID 2.3.2 Description Normalize a Vector of Numbers Page ___ of ___



INPUT

NUMERIC VECTOR

2.3

PROCESS

1 . Divide each element of the vector by the sum of the elements of the vector, and multiply each element by 100.

2 . Repeat step 1.

Return

OUTPUT

NUMERIC VECTOR

**Extended Description**

1. Performing this operation converts a group of arbitrary values to a group of values that add up to 100. The values all maintain the same relativity.

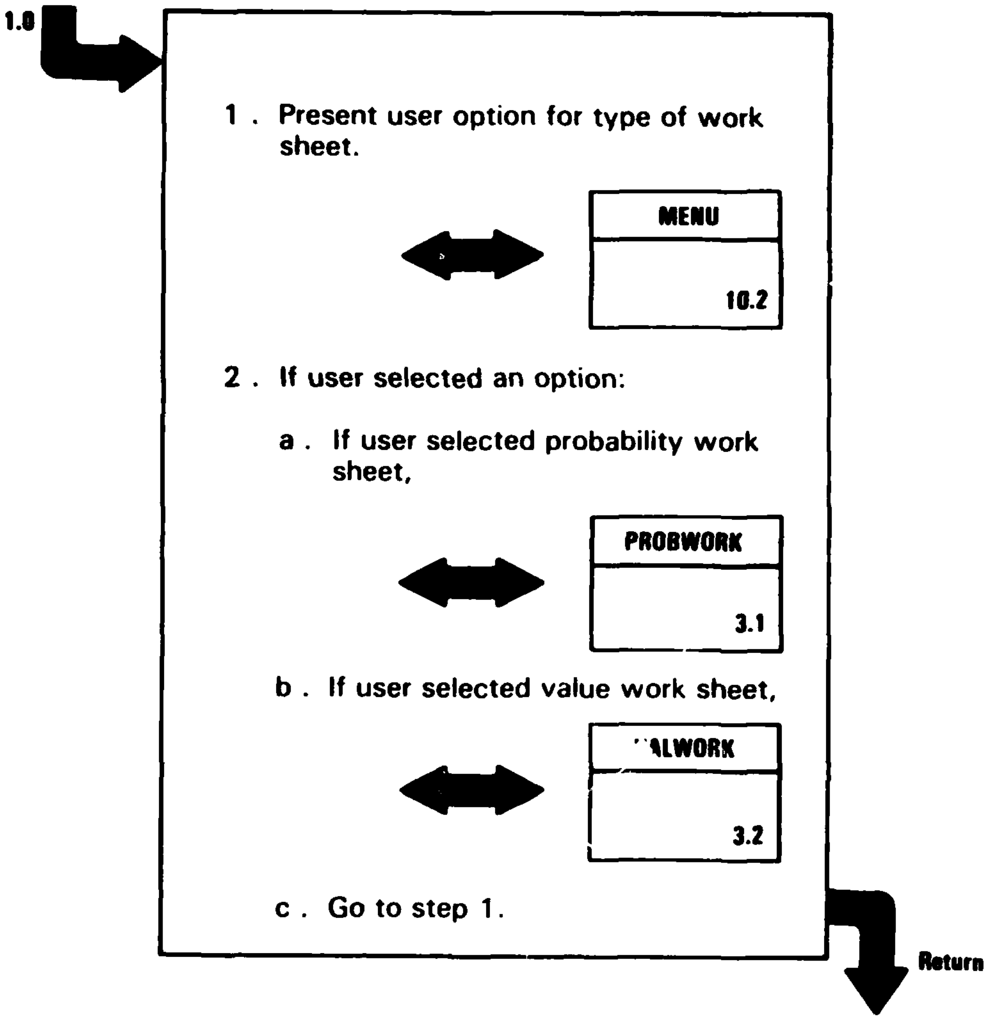
2. Performing this operation twice allows the case where the original values are all zero. The final result is a group of equal numbers that add up to 100.

System Program RUN Name WORK

Diagram ID 3.0 Description Work Sheet Page ___ of ___

INPUT

PROCESS



1 . Present user option for type of work sheet.

2 . If user selected an option:

a . If user selected probability work sheet,

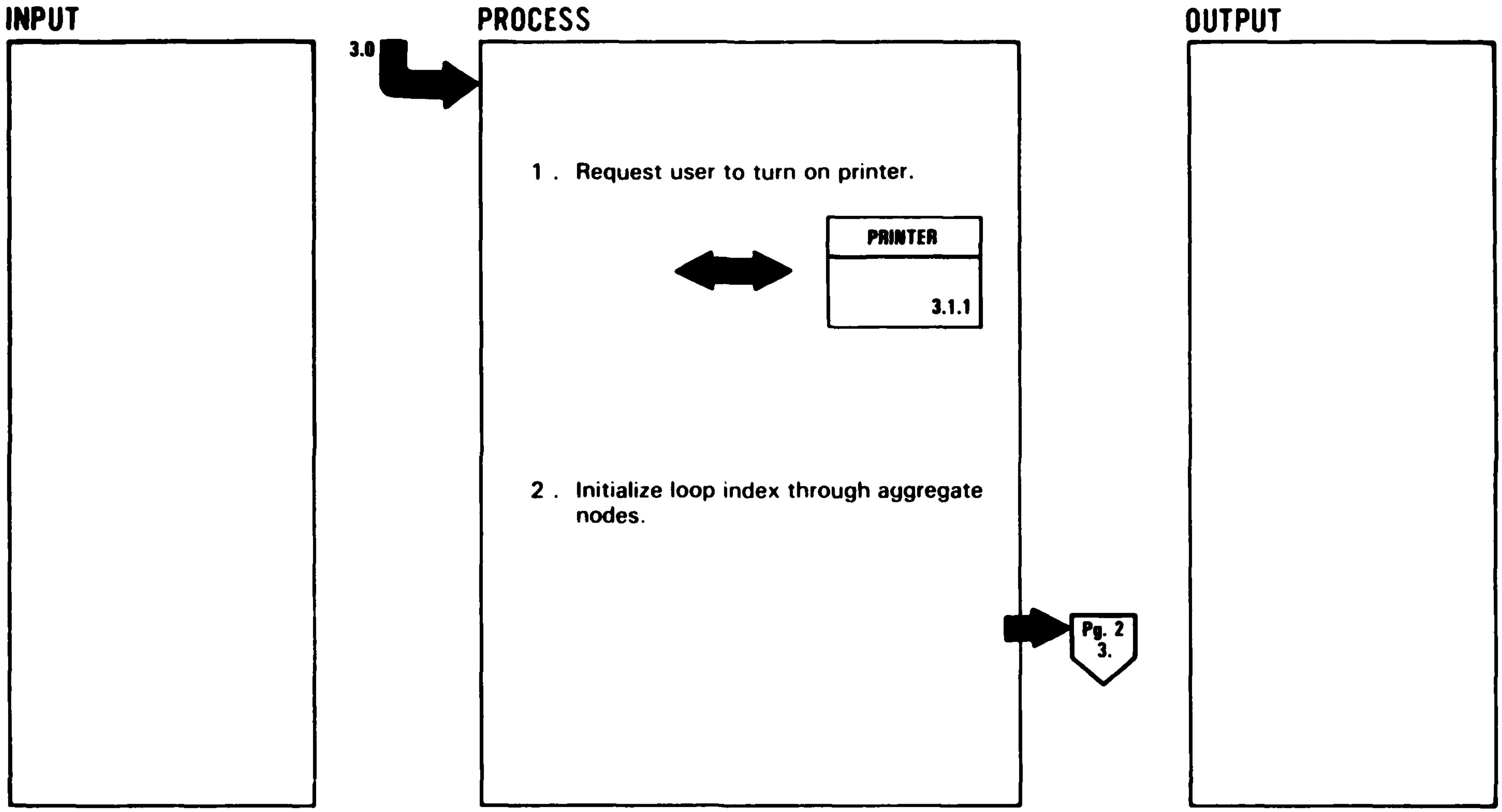
b . If user selected value work sheet,

c . Go to step 1.

OUTPUT

System Program RUN Name PROBWORK

Diagram ID 3.1 Description Print Probability Work Sheet Page 1 of 2

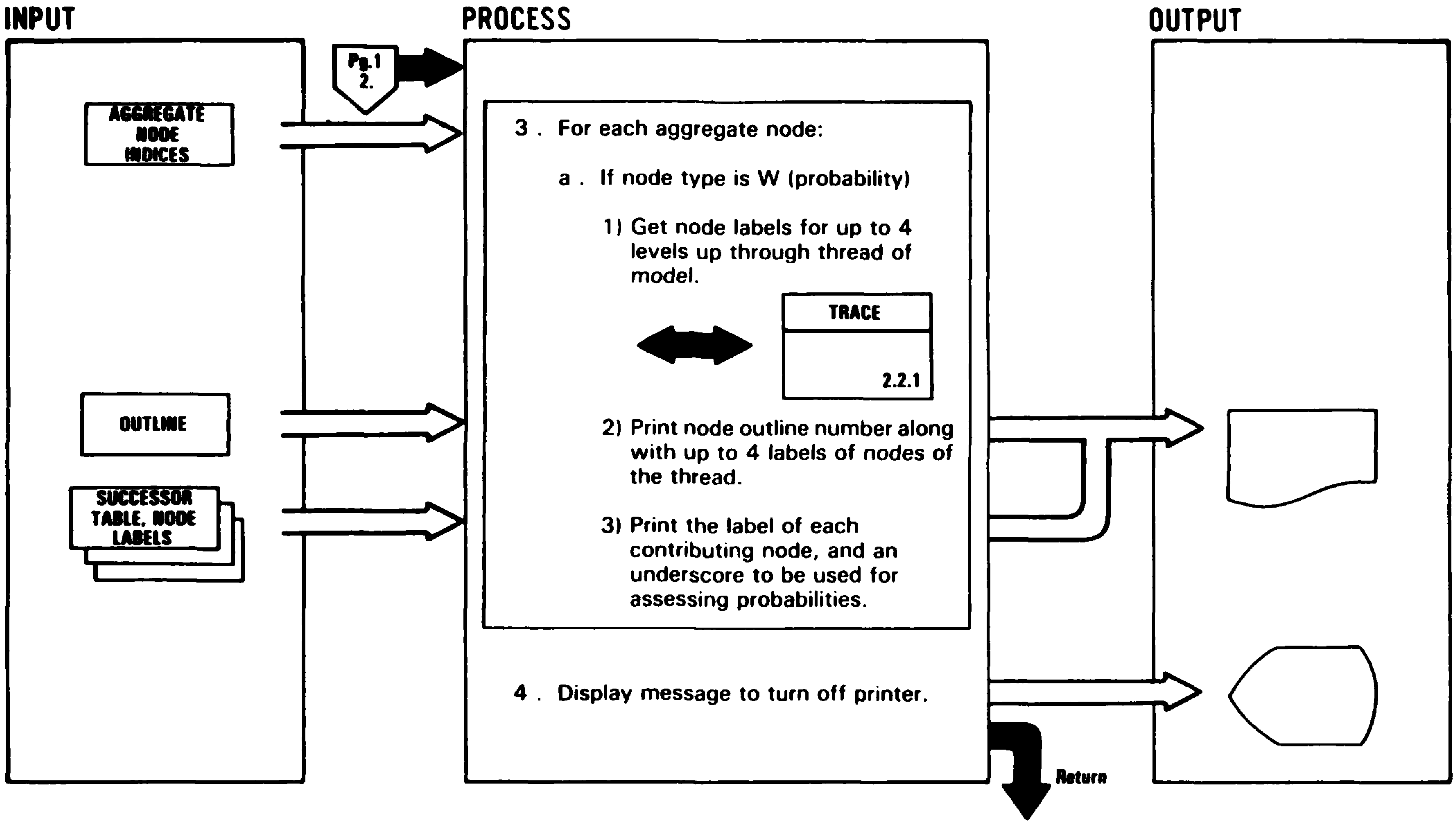


1 . Request user to turn on printer.

2 . Initialize loop index through aggregate nodes.

System Program RUN Name PROBWORK

Diagram ID 3.1 Description Print Probability Work Sheet Page 2 of 2



3 . For each aggregate node:

a . If node type is W (probability)

1) Get node labels for up to 4 levels up through thread of *model.*

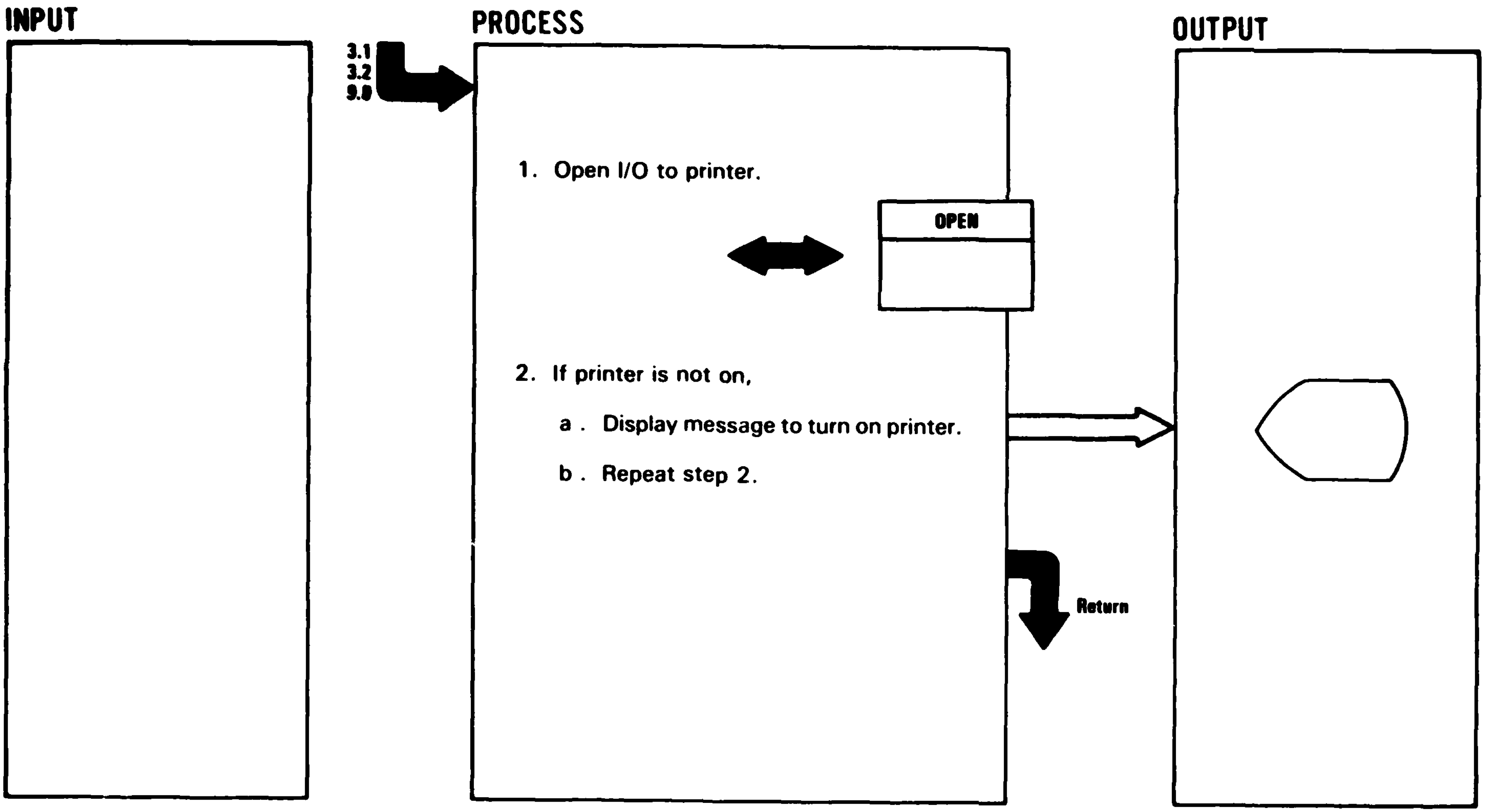
2) Print node outline number along with up to 4 labels of nodes of the thread.

3) Print the label of each contributing node, and an underscore to be used for assessing probabilities.

4 . Display message to turn off printer.

System Program RUN Name: PRINTER

Diagram ID 3.1.1 Description Request Printer Page ___ of ___



1. Open I/O to printer.

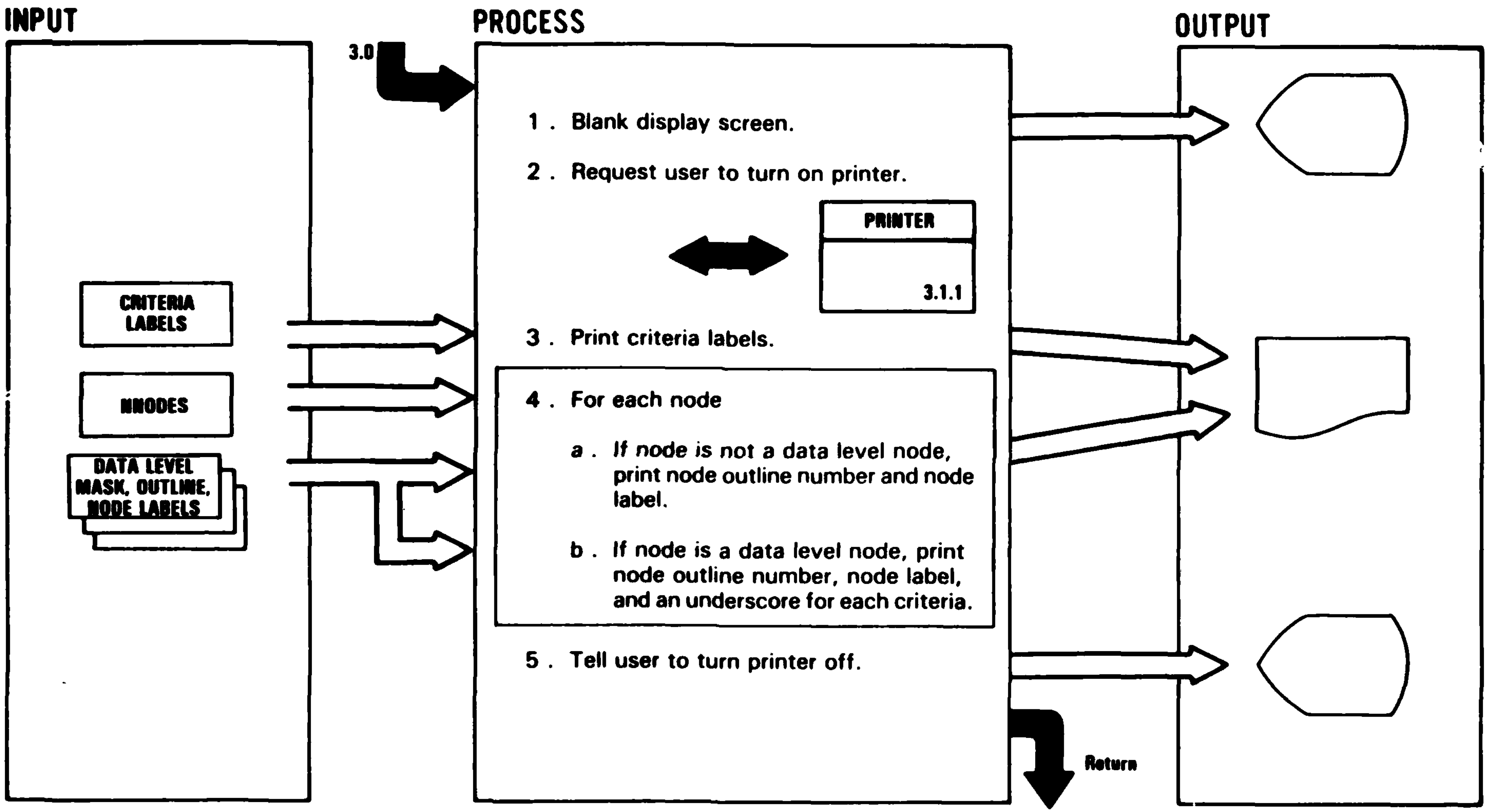
2. If printer is not on,

   a. Display message to turn on printer.

   b. Repeat step 2.

System Program RUN Name VALWORK

Diagram ID 3.2 Description Print Value Work Sheet Page ____ of ____



1 . Blank display screen.

2 . Request user to turn on printer.

3 . Print criteria labels.

4 . For each node

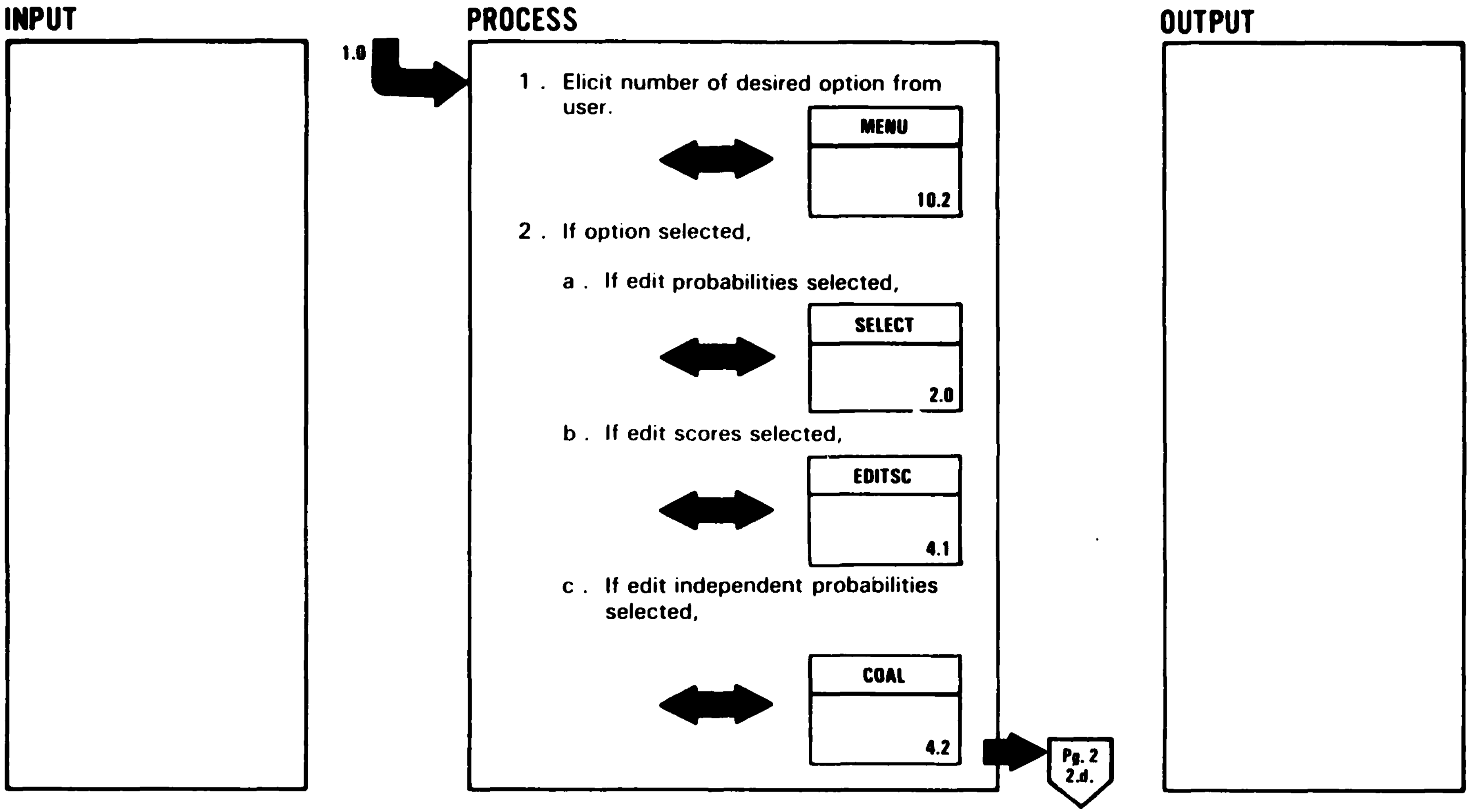
a . If node is not a data level node, print node outline number and node label.

b . If node is a data level node, print node outline number, node label, and an underscore for each criteria.

5 . Tell user to turn printer off.

System/Program: RUN Name EDITOR

Diagram ID: 4.0 Description Edit Probabilities Page 1 of 2



1 . Elicit number of desired option from user.

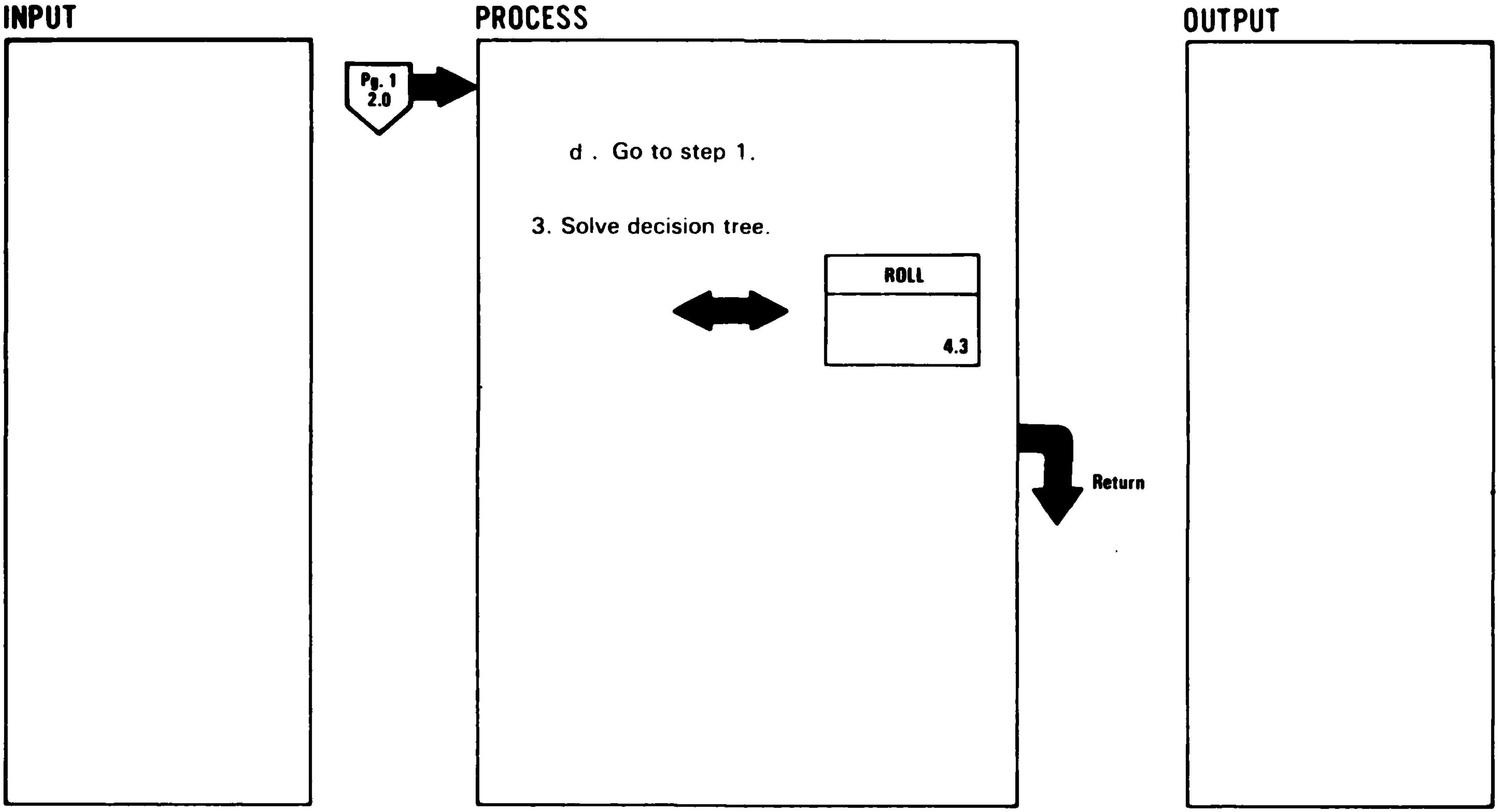
2 . If option selected,

a . If edit probabilities selected,

b . If edit scores selected,

c . If edit independent probabilities selected, System Program RUN Name EDITOR

Diagram ID 4.0 Description Edit Probabilities Page 2 of 2



INPUT

PROCESS

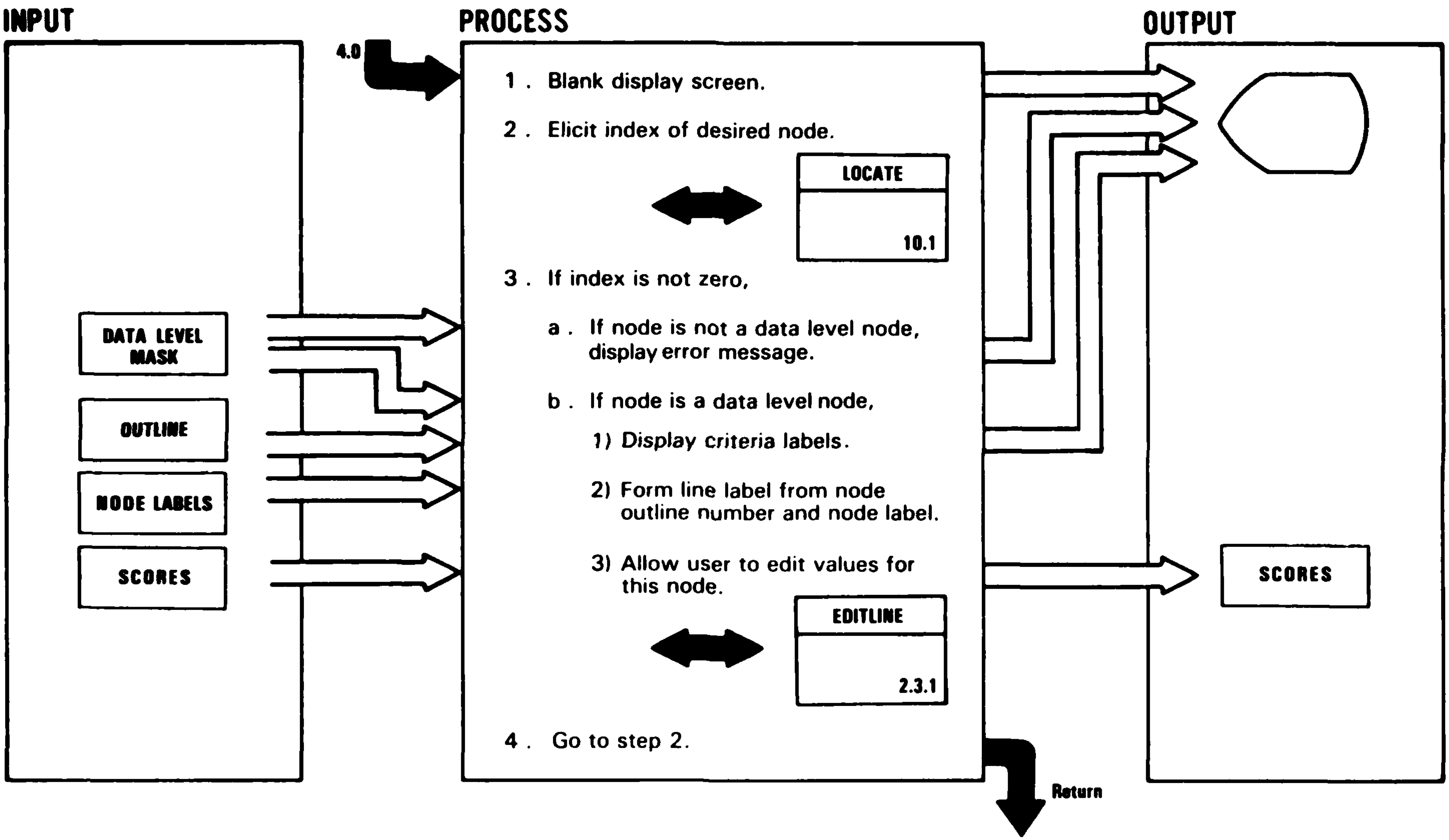
d . Go to step 1.

3. Solve decision tree.

OUTPUT

System/Program: RUN Name: EDITSC

Diagram ID: 4.1 Description Edit Scores Page: ___ of ___



1. Blank display screen.

2. Elicit index of desired node.

3. If index is not zero,

   a. If node is not a data level node, display error message.

   b. If node is a data level node,

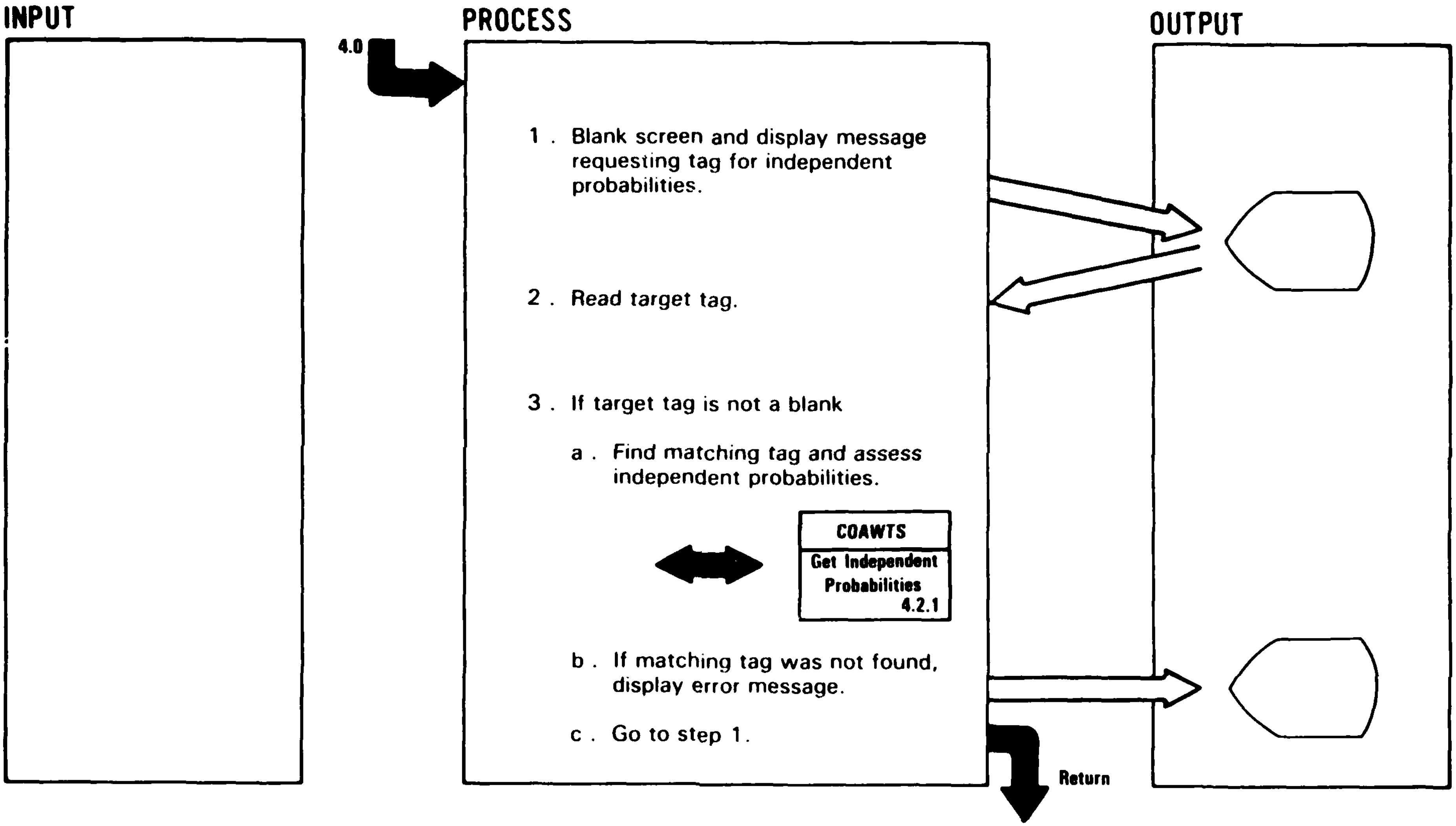
      1) Display criteria labels.

      2) Form line label from node outline number and node label.

      3) Allow user to edit values for this node.

4. Go to step 2.

System Program RUN Name COAL
Diagram ID 4.2 Description Edit Independent Probabilities Page __ of __



INPUT

PROCESS

OUTPUT

1 . Blank screen and display message requesting tag for independent probabilities.

2 . Read target tag.

3 . If target tag is not a blank

a . Find matching tag and assess independent probabilities.

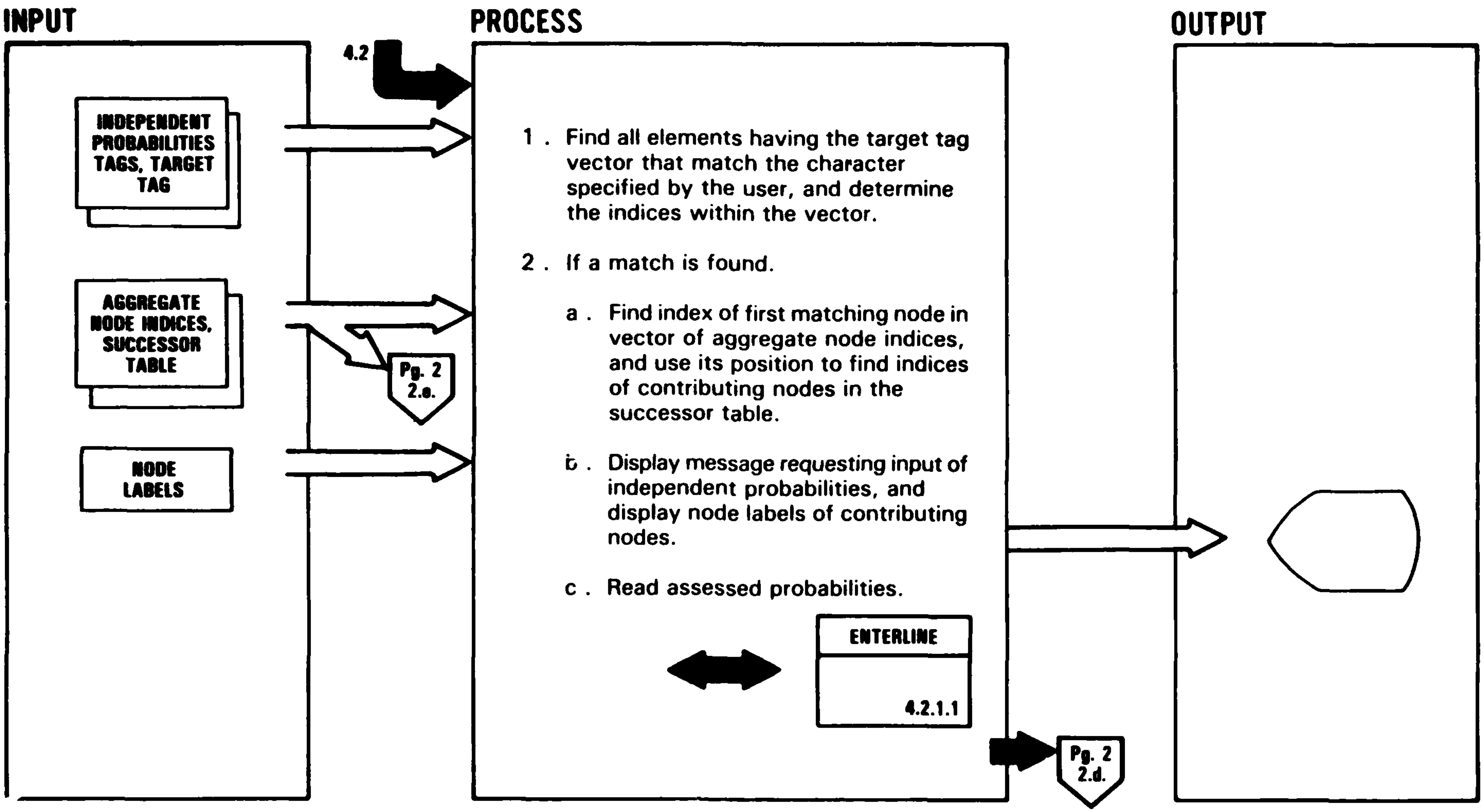
| COAWTS |
|---|
| Get Independent Probabilities<br>4.2.1 |

b . If matching tag was not found, display error message.

c . Go to step 1.

System/Program: RUN Name: COAWTS

Diagram ID: 4.2.1 Description Get Independent Probabilities Page: 1 of 2



INPUT

INDEPENDENT PROBABILITIES TAGS, TARGET TAG

AGGREGATE NODE INDICES, SUCCESSOR TABLE

NODE LABELS

PROCESS

4.2

1 . Find all elements having the target tag vector that match the character specified by the user, and determine the indices within the vector.

2 . If a match is found.

a . Find index of first matching node in vector of aggregate node indices, and use its position to find indices of contributing nodes in the successor table.

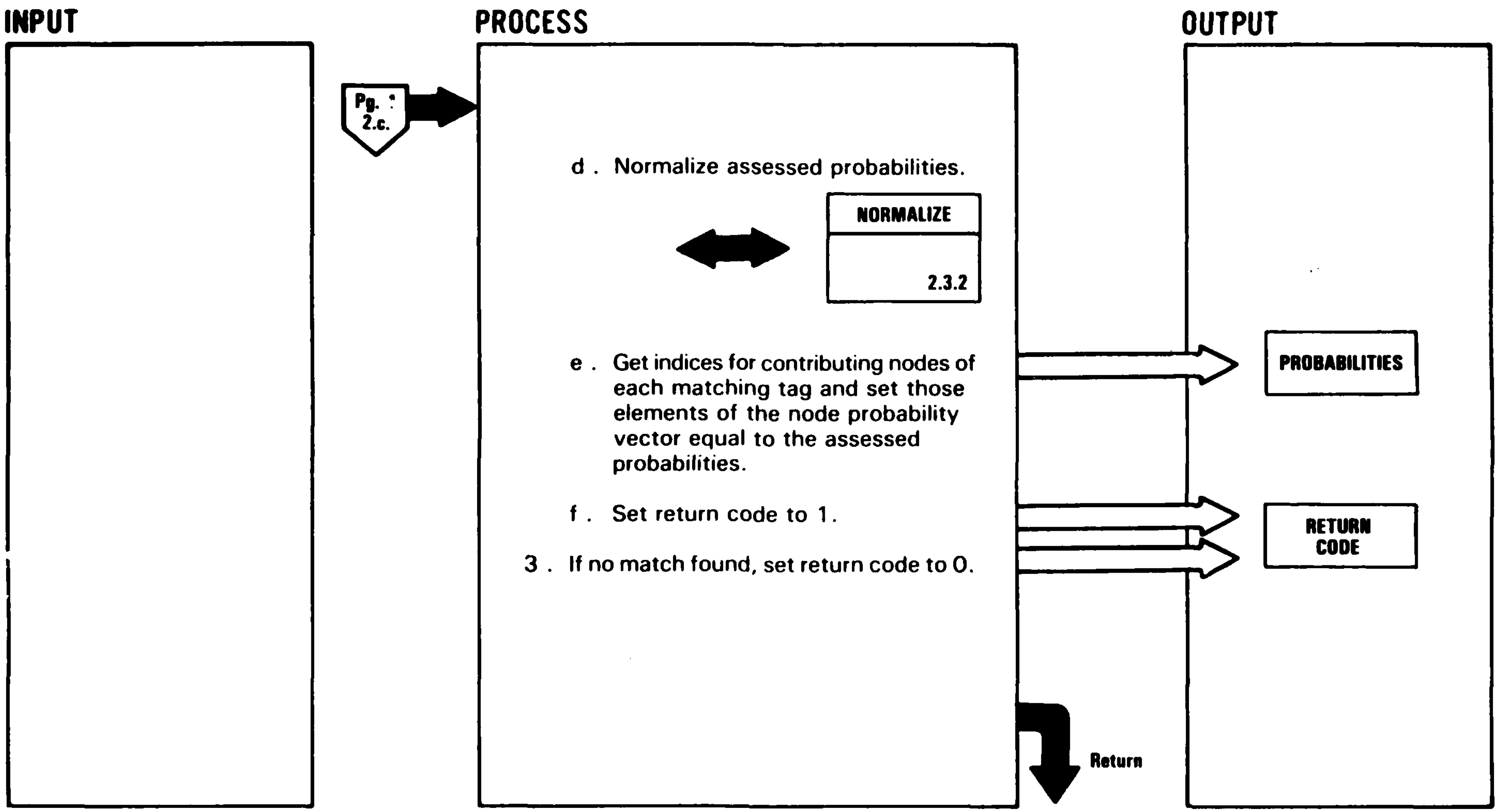
b . Display message requesting input of independent probabilities, and display node labels of contributing nodes.

c . Read assessed probabilities.

OUTPUT

System/Program: RUN Name: COAWTS

Diagram ID: 4.2.1 Description: Get Independent Probabilities Page: 2 of 2



d. Normalize assessed probabilities.

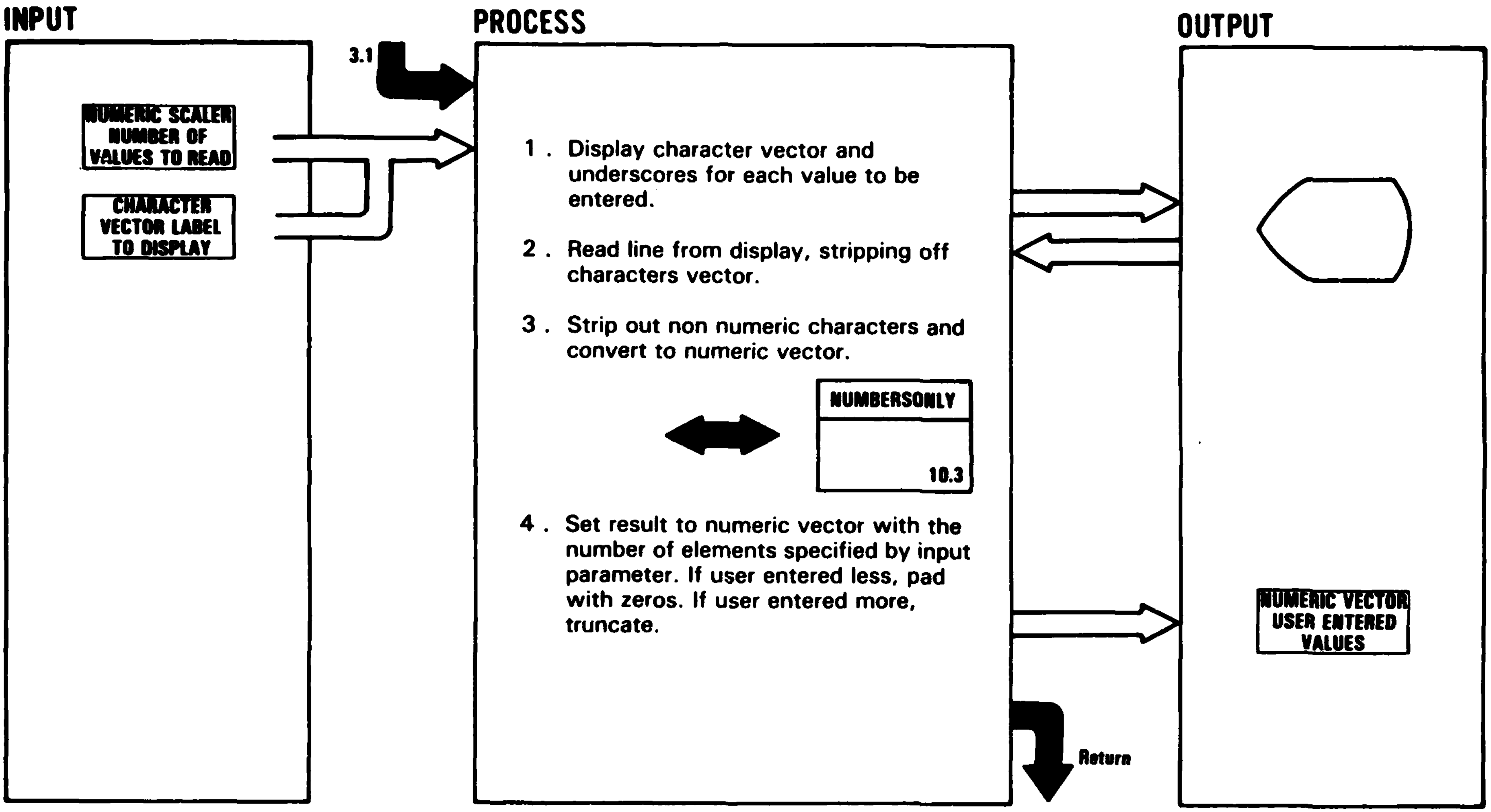
e. Get indices for contributing nodes of each matching tag and set those elements of the node probability vector equal to the assessed probabilities.

f. Set return code to 1.

3. If no match found, set return code to 0.

System/Program: RUN Name: ENTERLINE

Diagram ID. 4.2.1.1 Description Enter Numeric Vector Page: ___ of ___


INPUT
PROCESS
OUTPUT
NUMERIC SCALER NUMBER OF VALUES TO READ
CHARACTER VECTOR LABEL TO DISPLAY
3.1
NUMBERSONLY
10.3
NUMERIC VECTOR USER ENTERED VALUES
Return

1. Display character vector and underscores for each value to be entered.

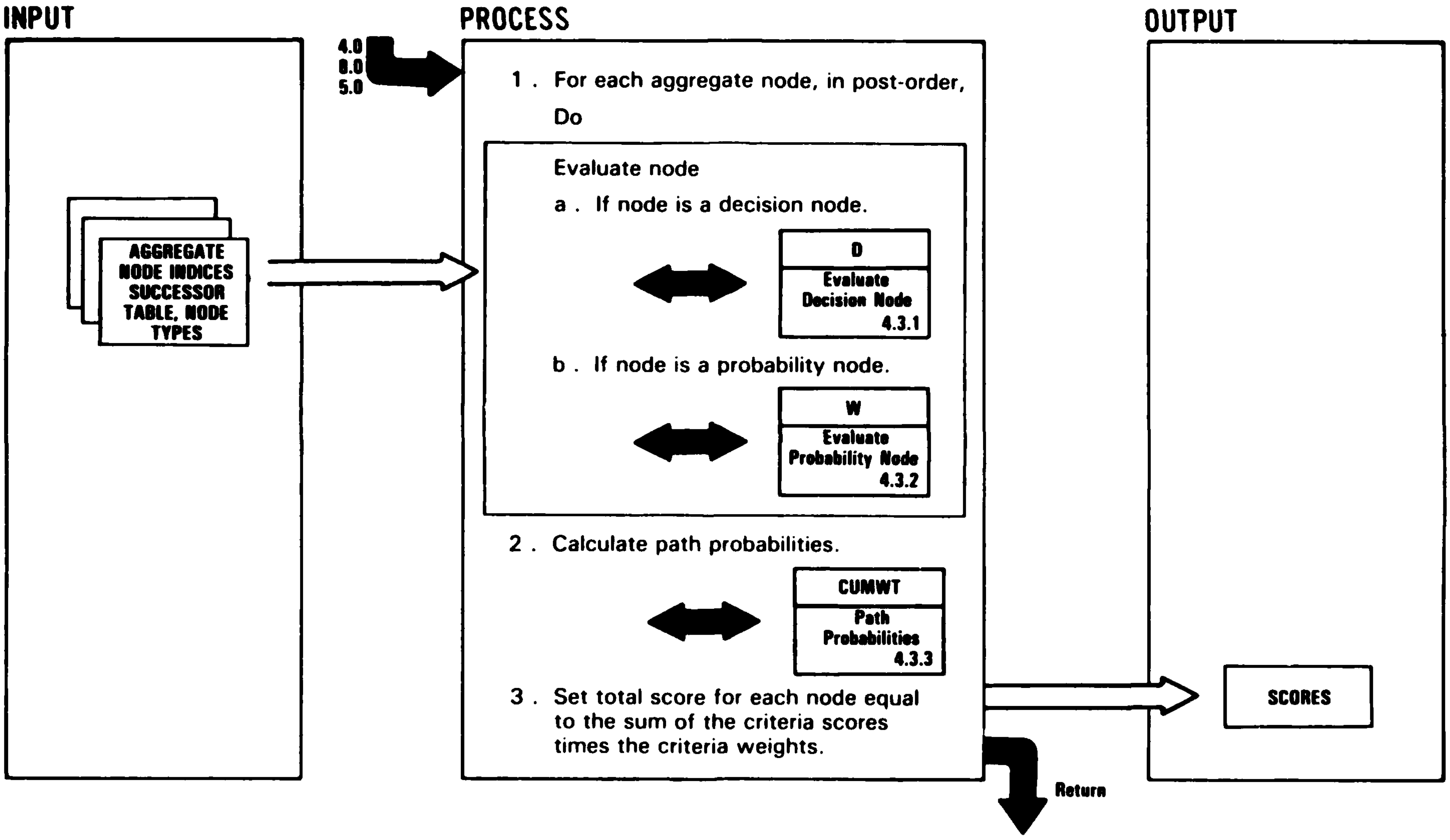
2. Read line from display, stripping off characters vector.

3. Strip out non numeric characters and convert to numeric vector.

4. Set result to numeric vector with the number of elements specified by input parameter. If user entered less, pad with zeros. If user entered more, truncate.

System Program RUN Name ROLL

Diagram ID 4.3 Description Solve Decision Tree Page ___ of ___



1 . For each aggregate node, in post-order,

Do

Evaluate node

a . If node is a decision node.

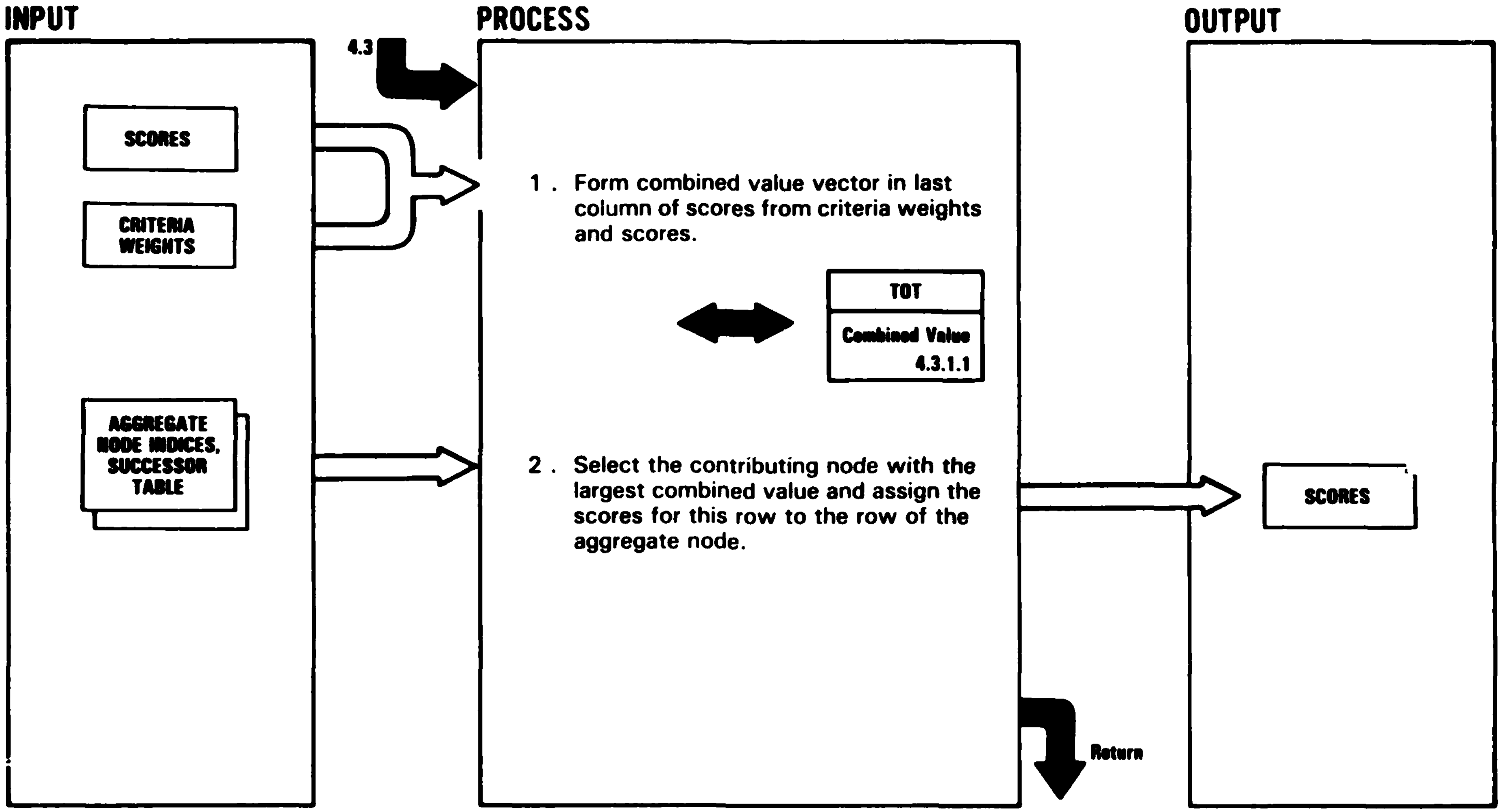
b . If node is a probability node.

2 . Calculate path probabilities.

3 . Set total score for each node equal to the sum of the criteria scores times the criteria weights.

System/Program: RUN Name: D

Diagram ID: 4.3.1 Description Evaluate Decision Node Page: ___ of ___

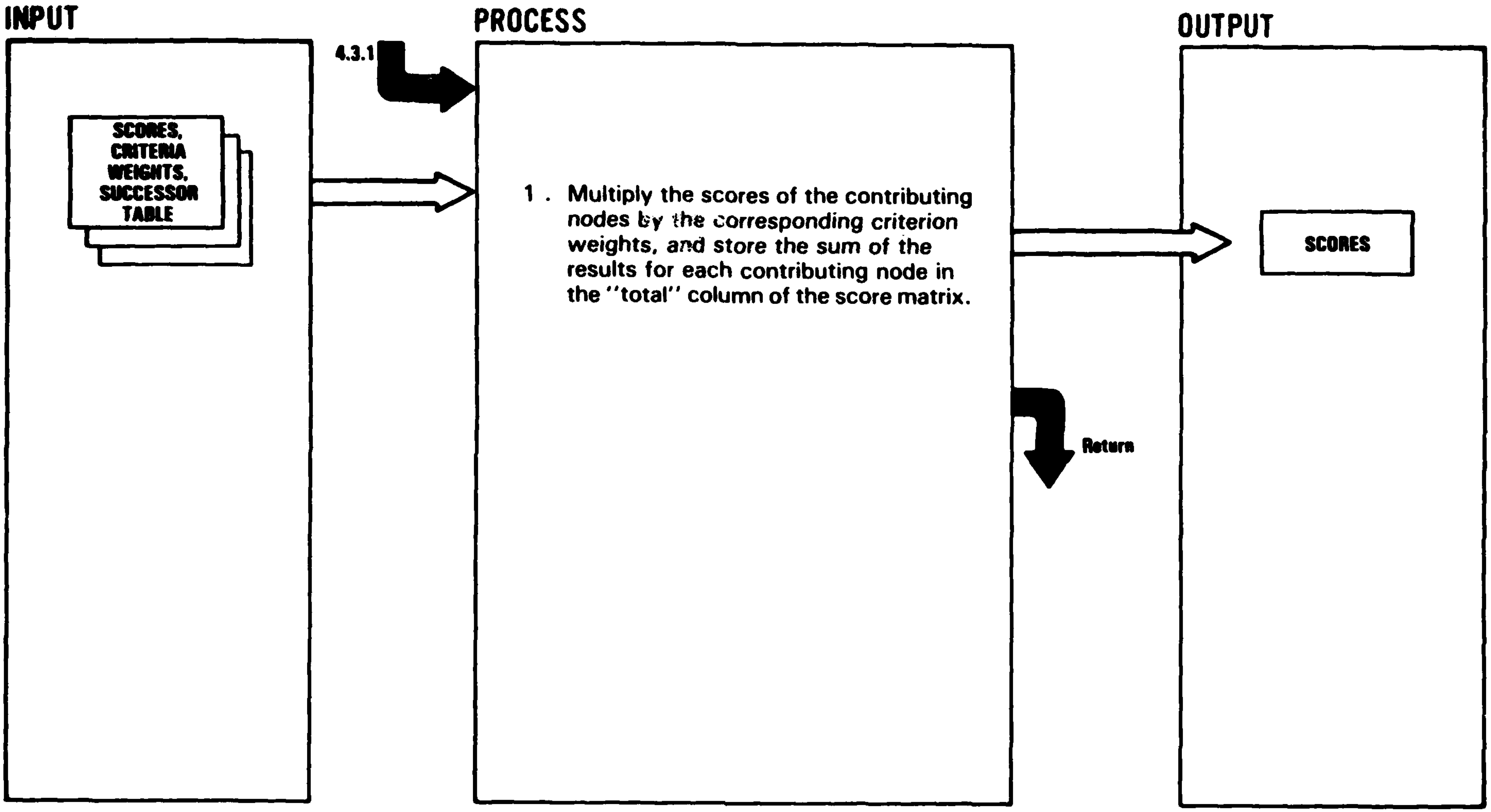


1 . Form combined value vector in last column of scores from criteria weights and scores.

2 . Select the contributing node with the largest combined value and assign the scores for this row to the row of the aggregate node.

System Program RUN Name: TOT

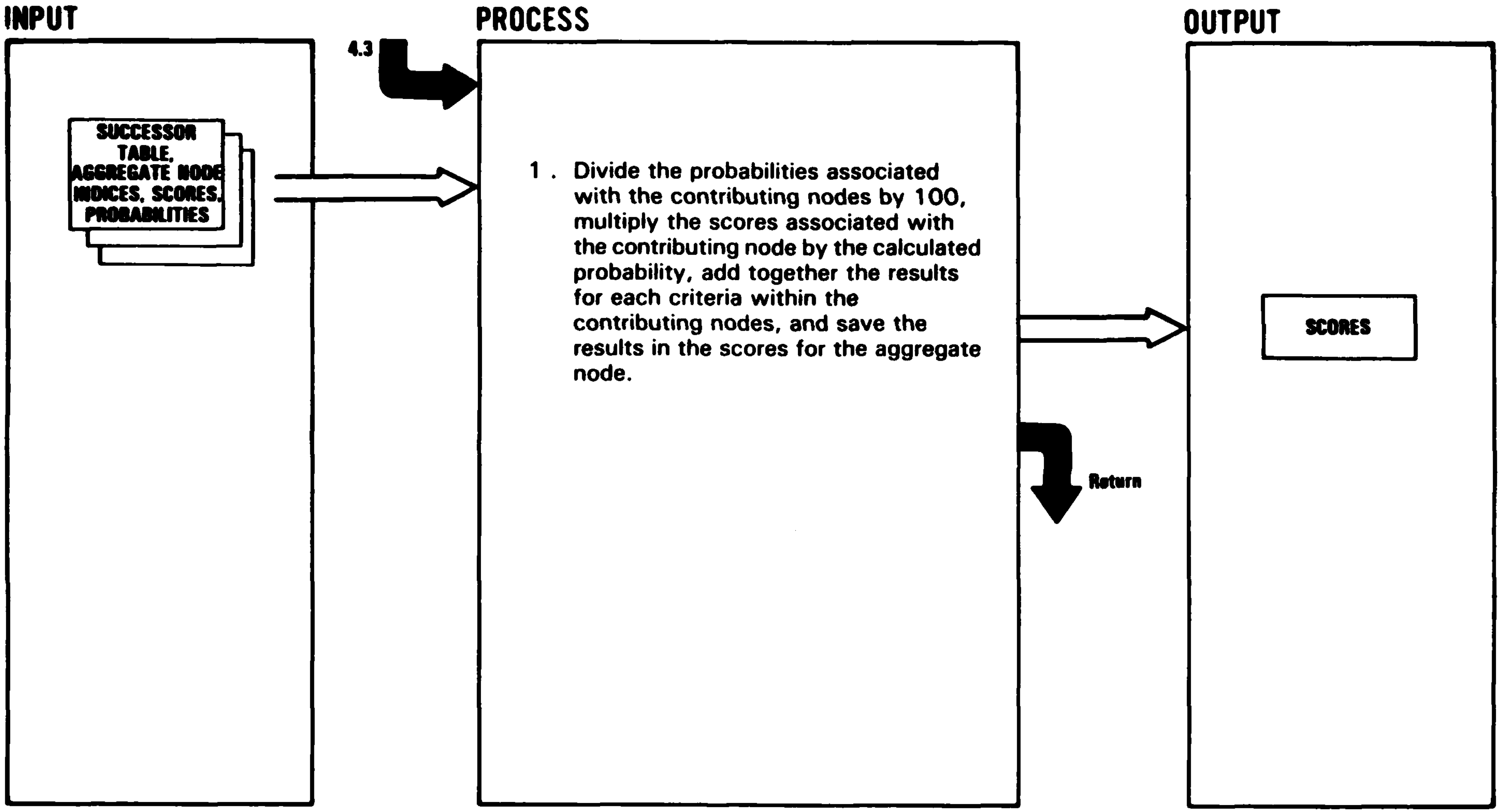
Diagram ID: 4.3.1.1 Description Compute Combined Value Page: ___ of ___



1 . Multiply the scores of the contributing nodes by the corresponding criterion weights, and store the sum of the results for each contributing node in the "total" column of the score matrix.

System/Program: RUN Name: W

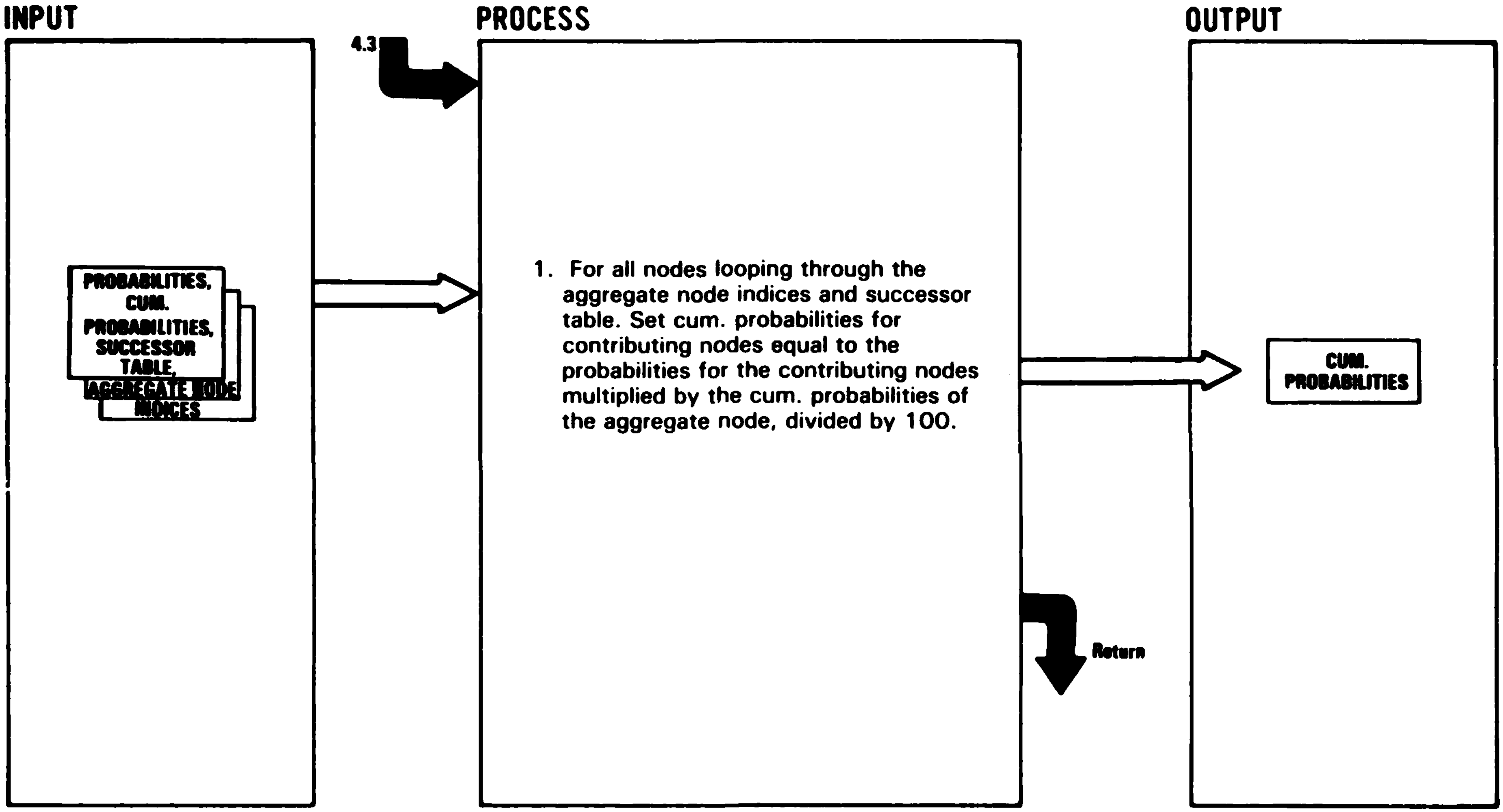
Diagram ID: 4.3.2 Description Evaluate Probability Node Page: ____ of ____


INPUT
PROCESS
OUTPUT
4.3
SUCCESSOR TABLE, AGGREGATE NODE INDICES, SCORES, PROBABILITIES
SCORES
Return

1 . Divide the probabilities associated with the contributing nodes by 100, multiply the scores associated with the contributing node by the calculated probability, add together the results for each criteria within the contributing nodes, and save the results in the scores for the aggregate node.

System/Program: RUN Name CUMWT

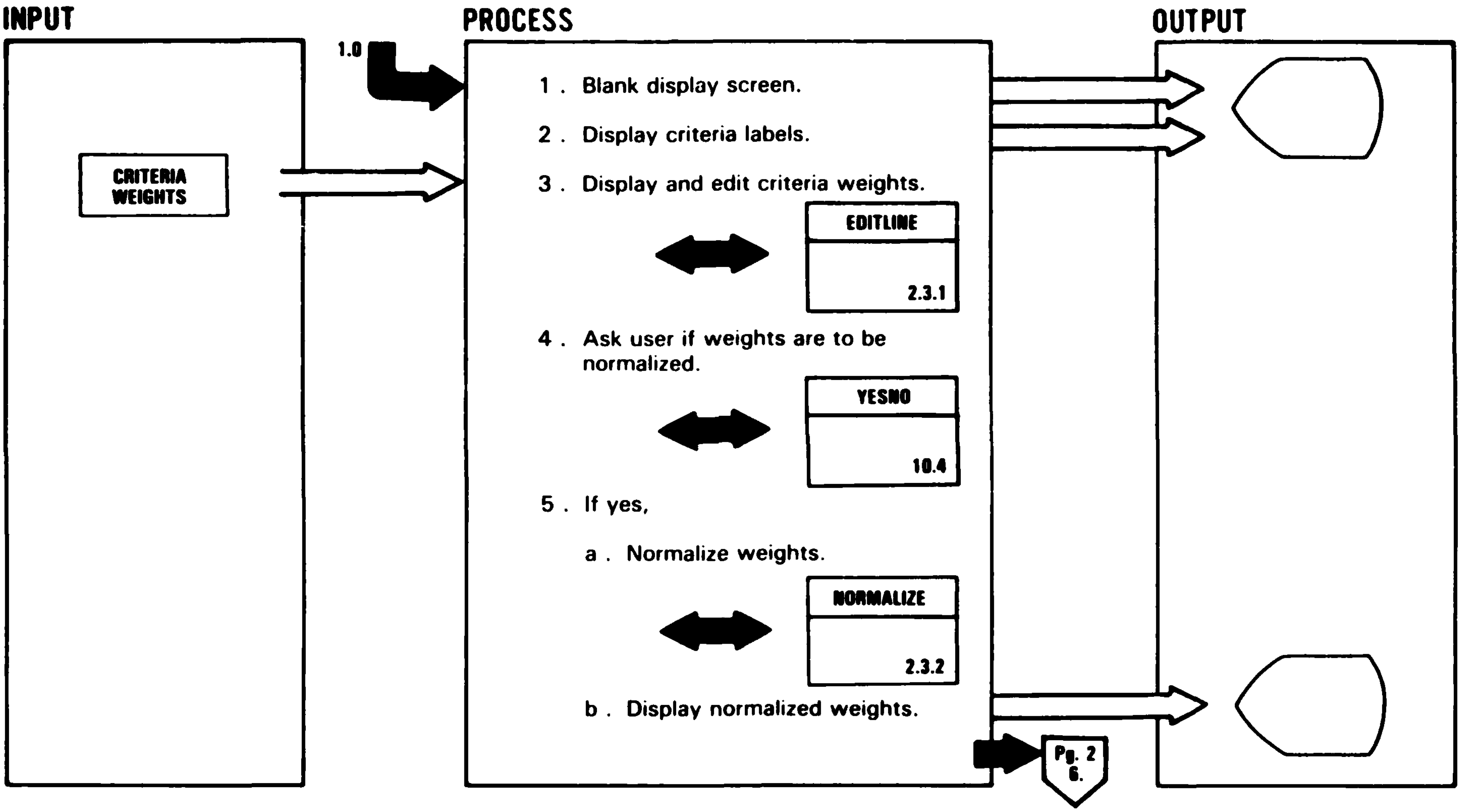
Diagram ID: 4.3.3 Description Calculate Cumulative Probabilities Page: ____ of ____



1. For all nodes looping through the aggregate node indices and successor table. Set cum. probabilities for contributing nodes equal to the probabilities for the contributing nodes multiplied by the cum. probabilities of the aggregate node, divided by 100.

System/Program: RUN Name: EDITW

Diagram ID: 5.0 Description: Edit Criteria Weights Page: 1 of 2



**INPUT**

CRITERIA WEIGHTS

**PROCESS**

1.0

1 . Blank display screen.

2 . Display criteria labels.

3 . Display and edit criteria weights.

EDITLINE 2.3.1

4 . Ask user if weights are to be normalized.

YESNO 10.4

5 . If yes,

a . Normalize weights.

NORMALIZE 2.3.2

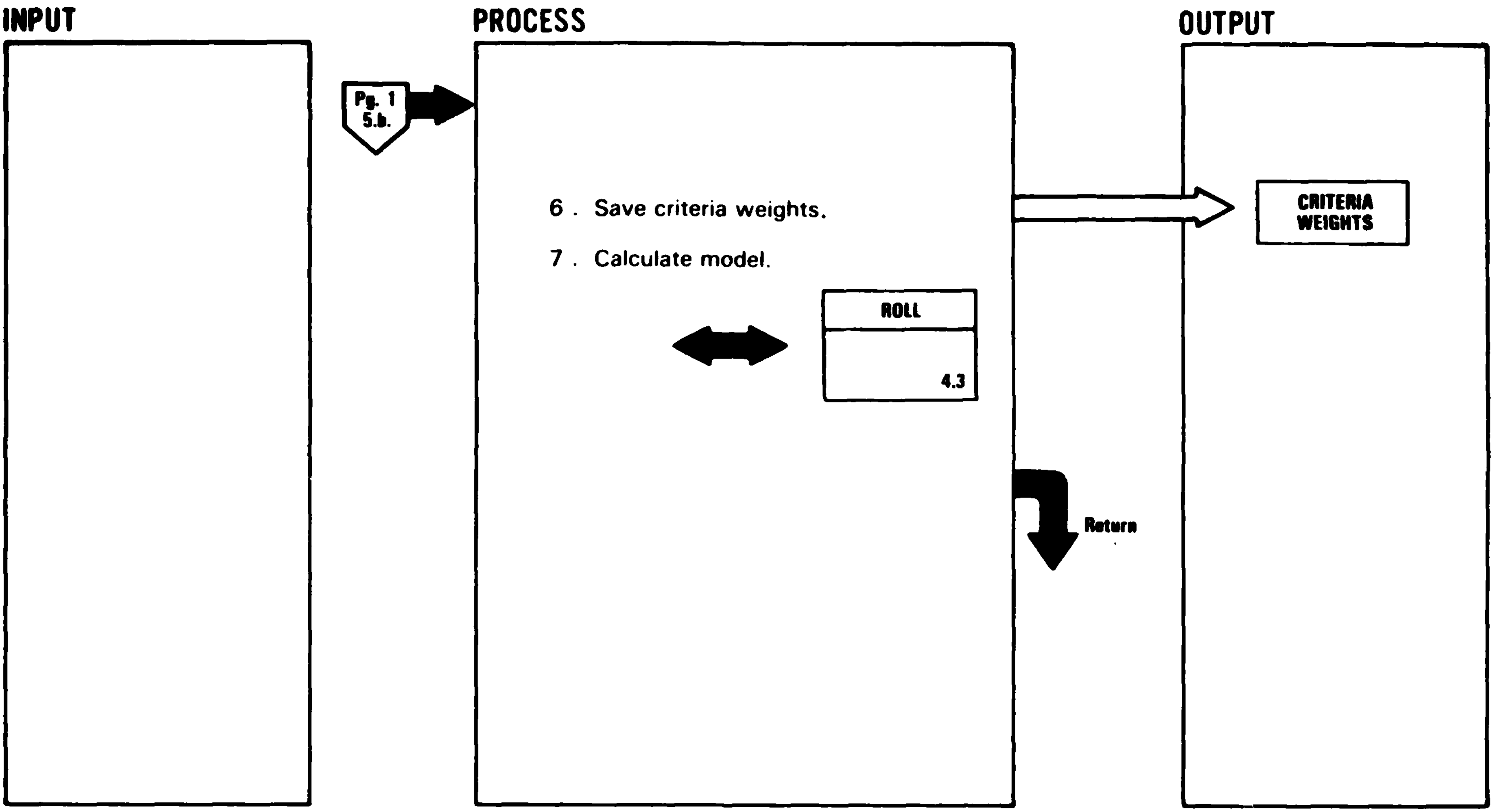
b . Display normalized weights.

Pg. 2 6.

**OUTPUT**

System/Program RUN Name EDITW

Diagram ID: 5.0 Description Edit Criteria Weights Page 2 of 2

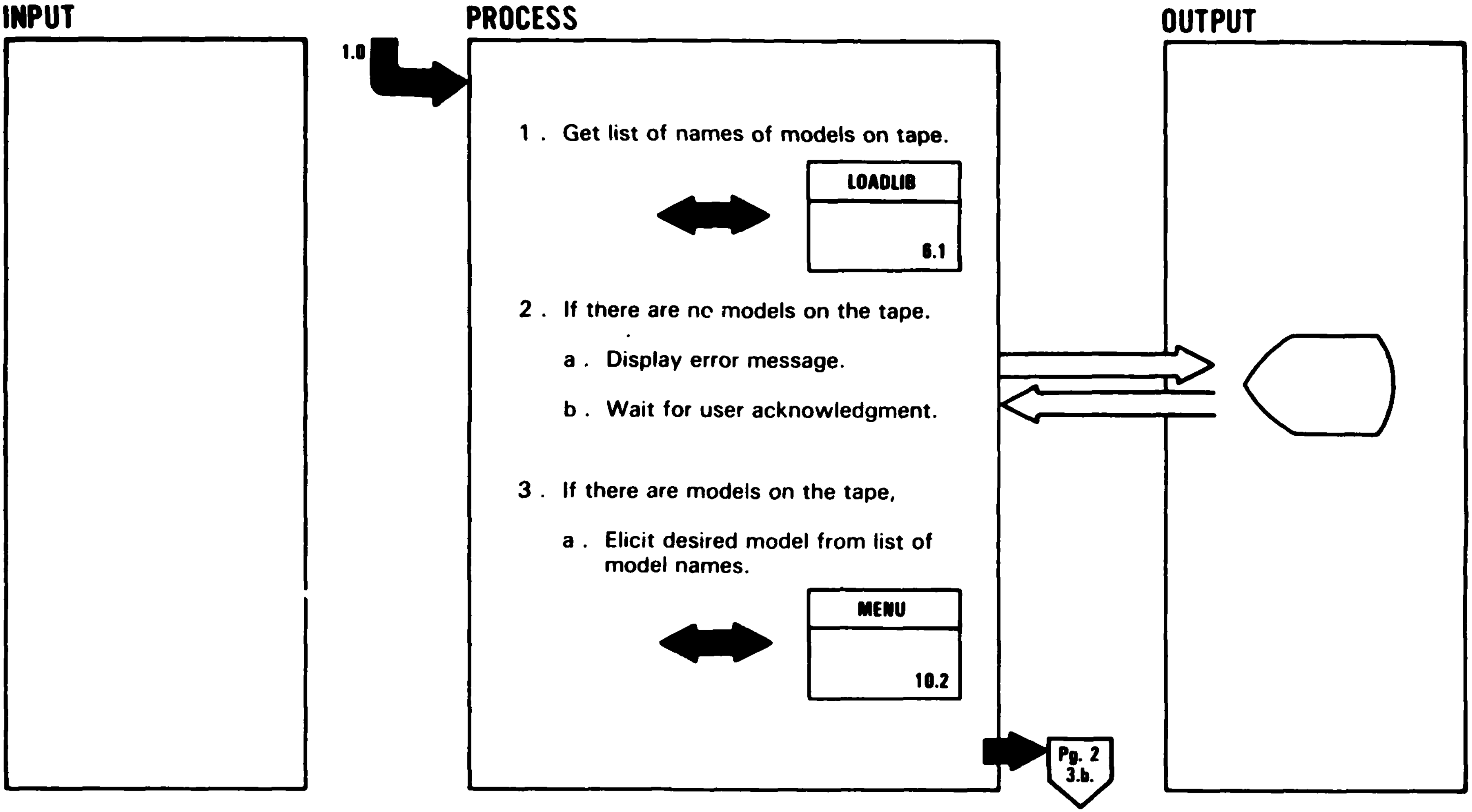


6 . Save criteria weights.

7 . Calculate model.

System/Program: RUN Name: LOADDRIVE

Diagram ID: 6.0 Description Load Model Page: 1 of 2



INPUT

PROCESS

OUTPUT

1 . Get list of names of models on tape.

2 . If there are nc models on the tape.

a . Display error message.

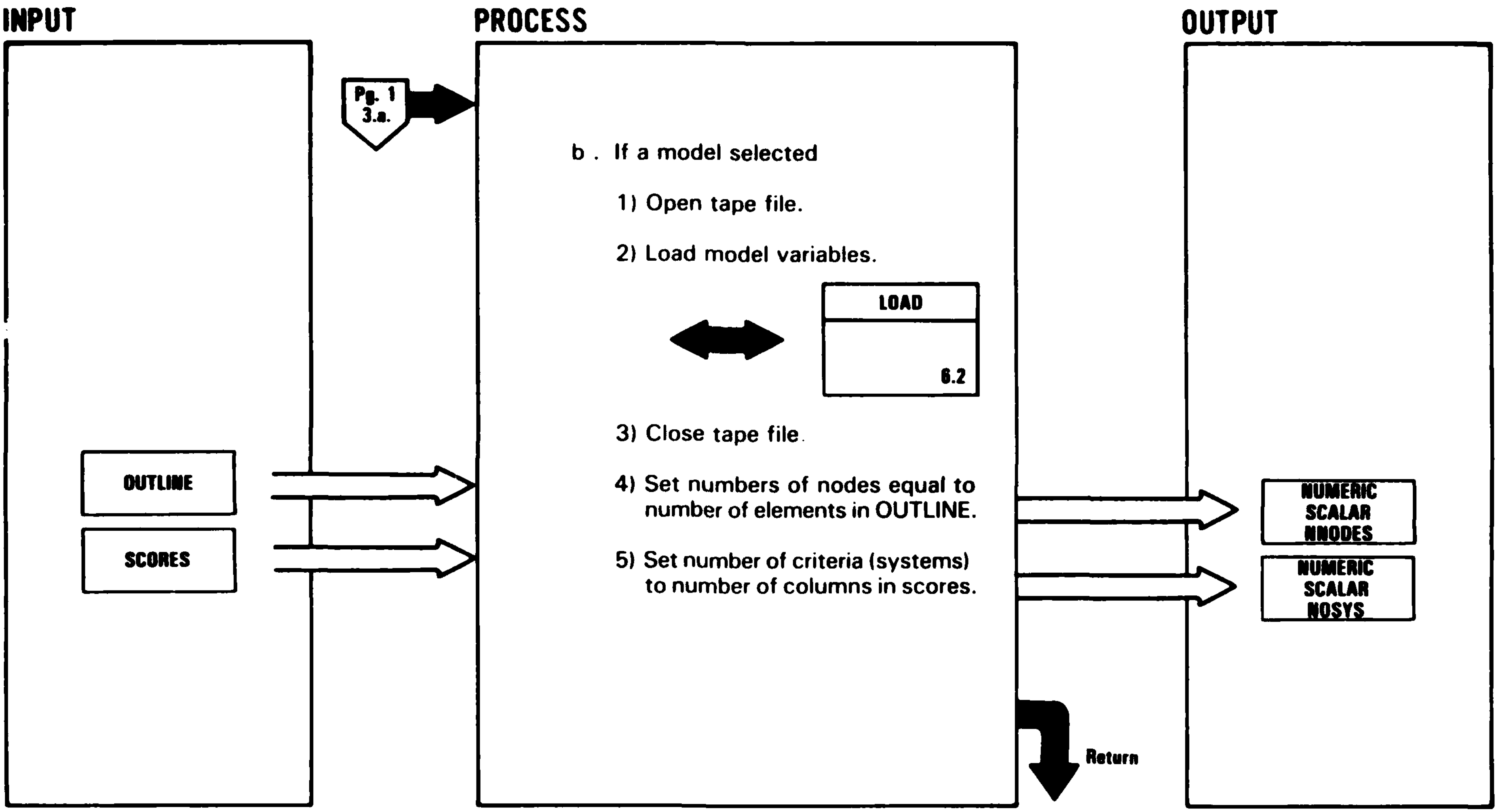
b . Wait for user acknowledgment.

3 . If there are models on the tape,

a . Elicit desired model from list of model names.

System/Program RUN Name LOADDRIVE

Diagram ID 6.0 Description Load Model Page 2 of 2



INPUT

PROCESS

OUTPUT

b . If a model selected

1) Open tape file.

2) Load model variables.

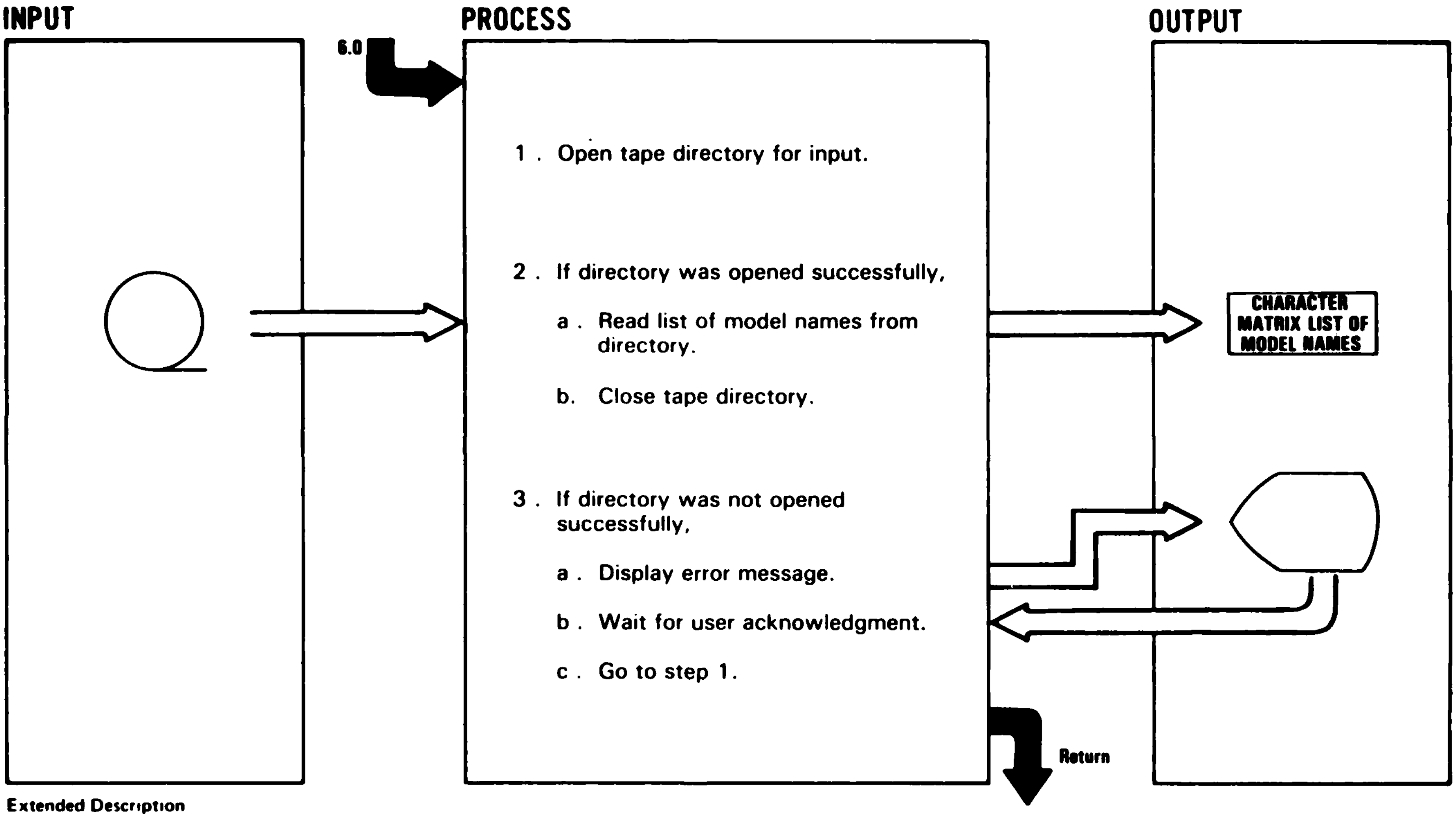
3) Close tape file.

4) Set numbers of nodes equal to number of elements in OUTLINE.

5) Set number of criteria (systems) to number of columns in scores.

System Program RUN Name LOADLIB

Diagram ID 6.1 Description Load Model Names Page ___ of ___



INPUT

PROCESS

1 . Open tape directory for input.

2 . If directory was opened successfully,

   a . Read list of model names from directory.

   b. Close tape directory.

3 . If directory was not opened successfully,

   a . Display error message.

   b . Wait for user acknowledgment.

   c . Go to step 1.

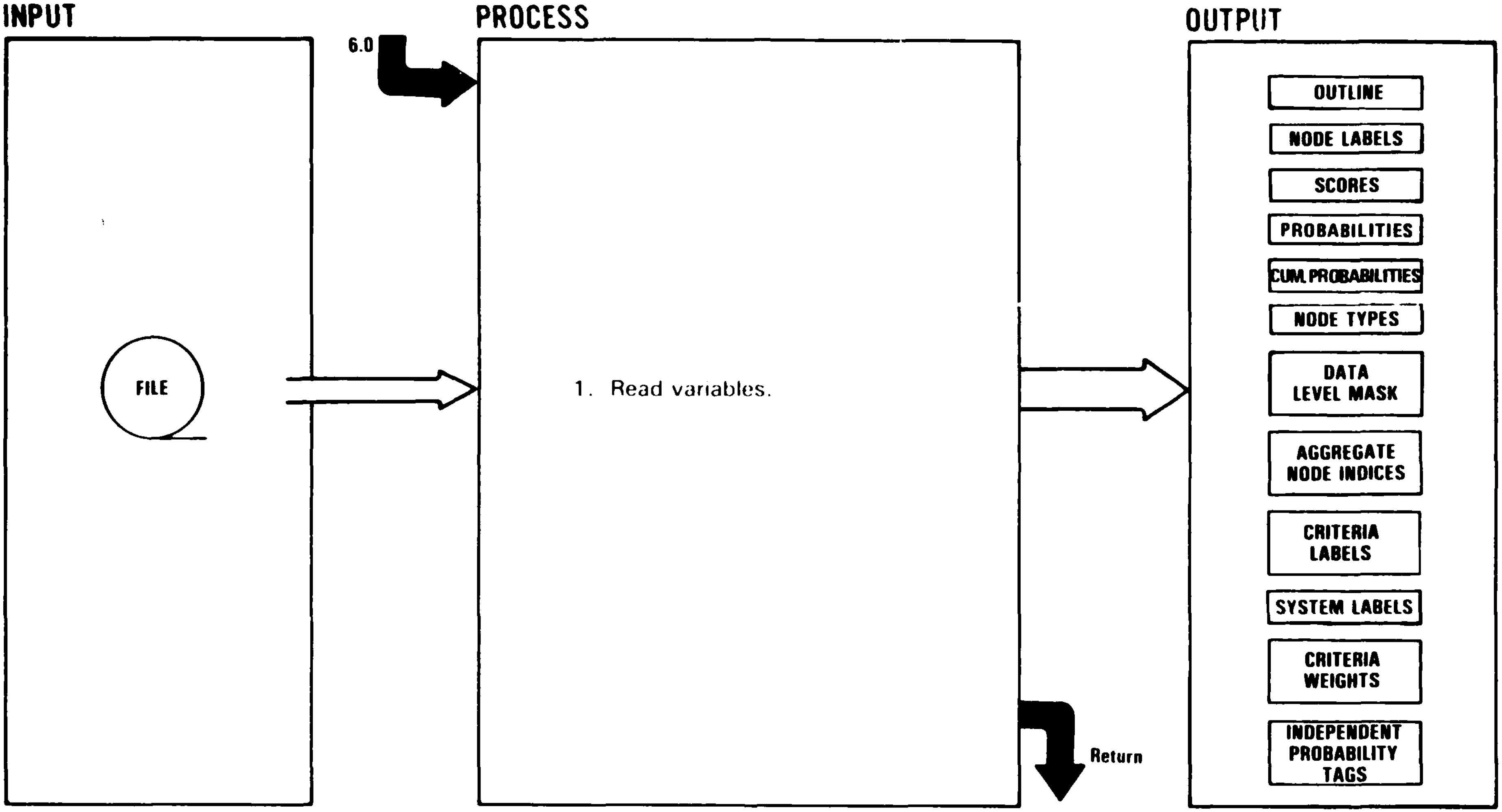
OUTPUT

**Extended Description**

Position of model names within list indicates where models are stored on tape.

System Program RUN Name LOAD

Diagram ID 6.2 Description Load Model Variables Page 1 of 2



1. Read variables.

**Extended Description**

1. The OUTLINE Table contains an element for each node in the model, sorted in numerical order. The value is an encoded representation of the node outline number supplied for each node when the model is entered. (See STRUCTURE.)

2. The NODE LABELS contain an element for each node (in the same order as OUTLINE) consisting of the description of each node supplied when the model is entered.

3. SCORES is a numeric matrix containing the values assigned to each criteria plus an extra element for the total score for each node of the model. (The node dimension is in the same order as OUTLINE.)

4. The PROBABILITIES contain the relative importance assigned to each node in the model. The elements are in the same order as OUTLINE.

5. The CUM. PROBABILITIES contain the percentage of the importance of the entire model at each node level.

6. The NODE TYPES contain an indication of the type of calculation to be used in assessing SCORES and WEIGHTS.

7. The DATA LEVEL MASK indicates which nodes are at the data level (bottom level) vs. the nodes that are aggregate nodes.

System/Program: RUN Name: LOAD

Diagram ID: 6.2 Description: Load Model Variables Page: 2 of 2

**INPUT**

**PROCESS**

**OUTPUT**

**Extended Description**

8. The AGGREGATE NODE INDICES contain the indices into the model variables that relate to just the aggregate nodes (all nodes that have one or more nodes contributing to them).

9. The SUCCESSOR TABLE is a matrix containing the indices of the nodes that contribute to the aggregate nodes. There is a row for each aggregate node.

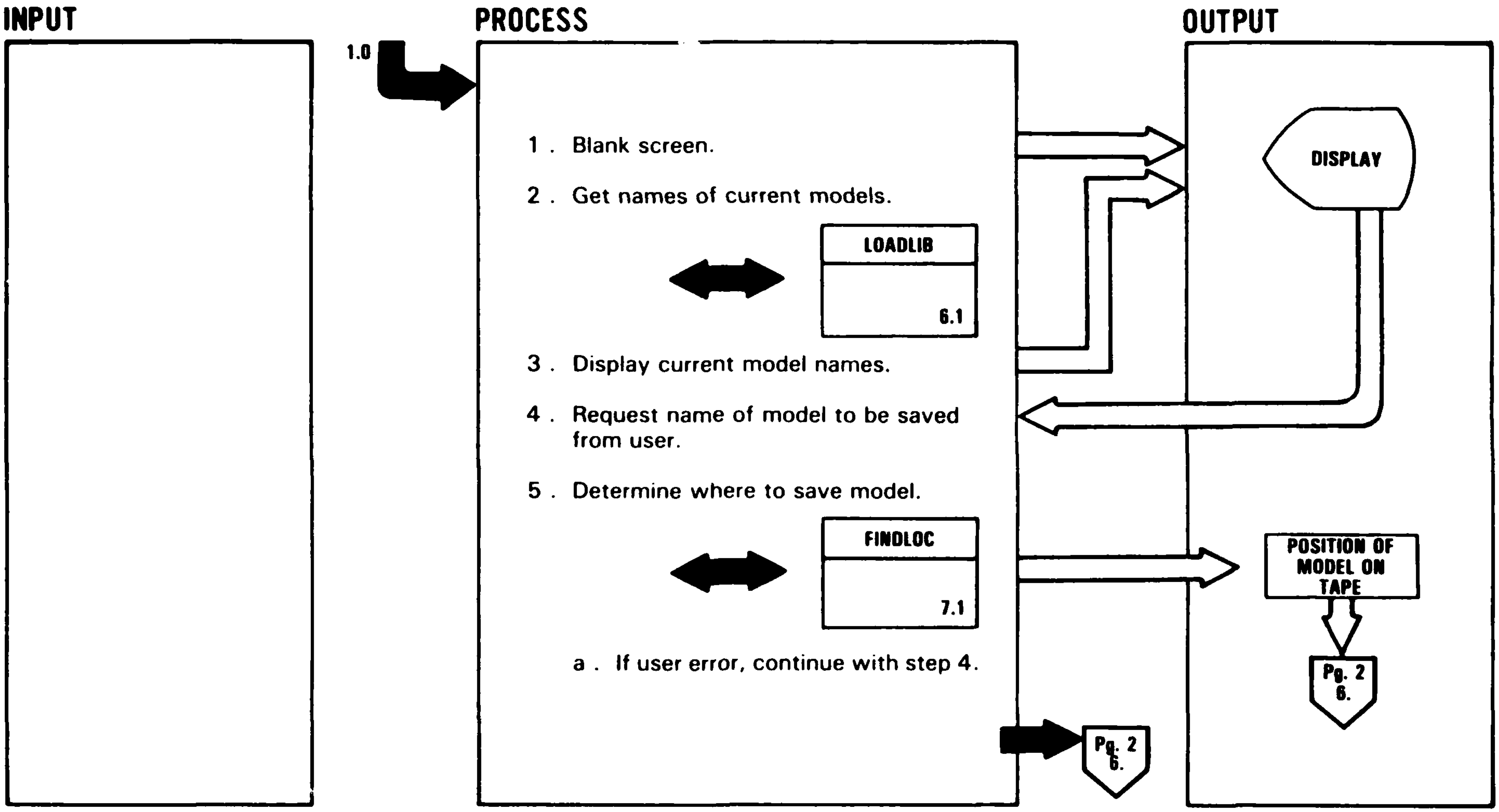
10. The CRITERIA LABELS contain the character discriptions of the criteria being evaluated.

11. The CRITERIA WEIGHTS contain the weights to be applied to each criterion when the decision tree is solved. The number of elements is equal to the number of criteria plus one for the total.

12. The INDEPENDENT PROBABILITY TAGS indicate groups of events that occur more than once in the tree and whose probabilities can be assessed all at once. The number and order of elements is the same as that for OUTLINE.

System/Program: RUN Name: SAVEDRIVE

Diagram ID: 7.0 Description Save Model Page 1 of 2



1 . Blank screen.

2 . Get names of current models.

3 . Display current model names.

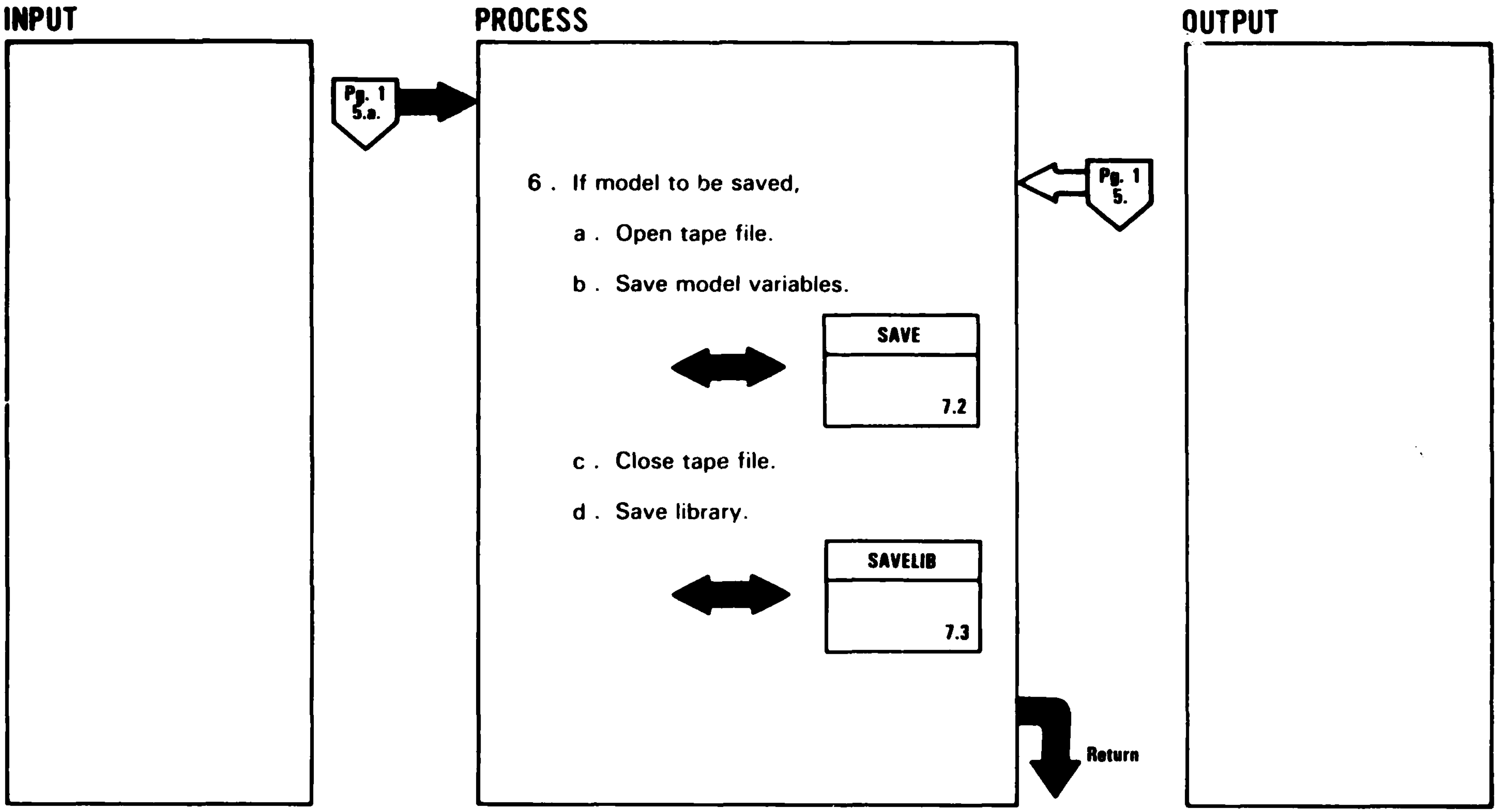
4 . Request name of model to be saved from user.

5 . Determine where to save model.

a . If user error, continue with step 4.

System/Program: RUN Name: SAVEDRIVE

Diagram ID: 7.0 Description Save Model Page: 2 of 2



6 . If model to be saved,

a . Open tape file.

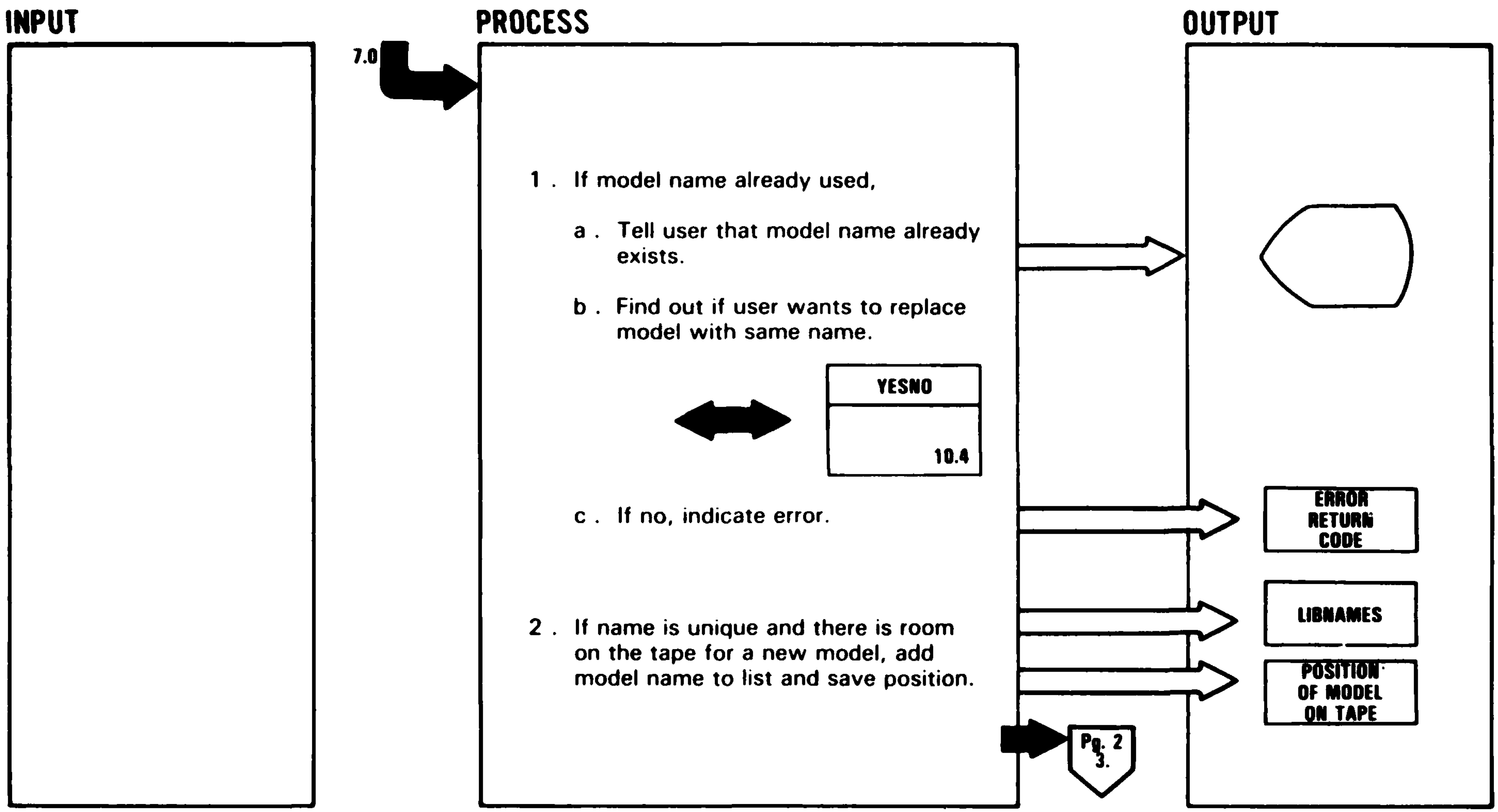
b . Save model variables.

c . Close tape file.

d . Save library.

System/Program: RUN Name: FINDLOC

Diagram ID: 7.1 Description Determine Where to Save Model Page: 1 of 2



INPUT

PROCESS

OUTPUT

1 . If model name already used,

a . Tell user that model name already exists.

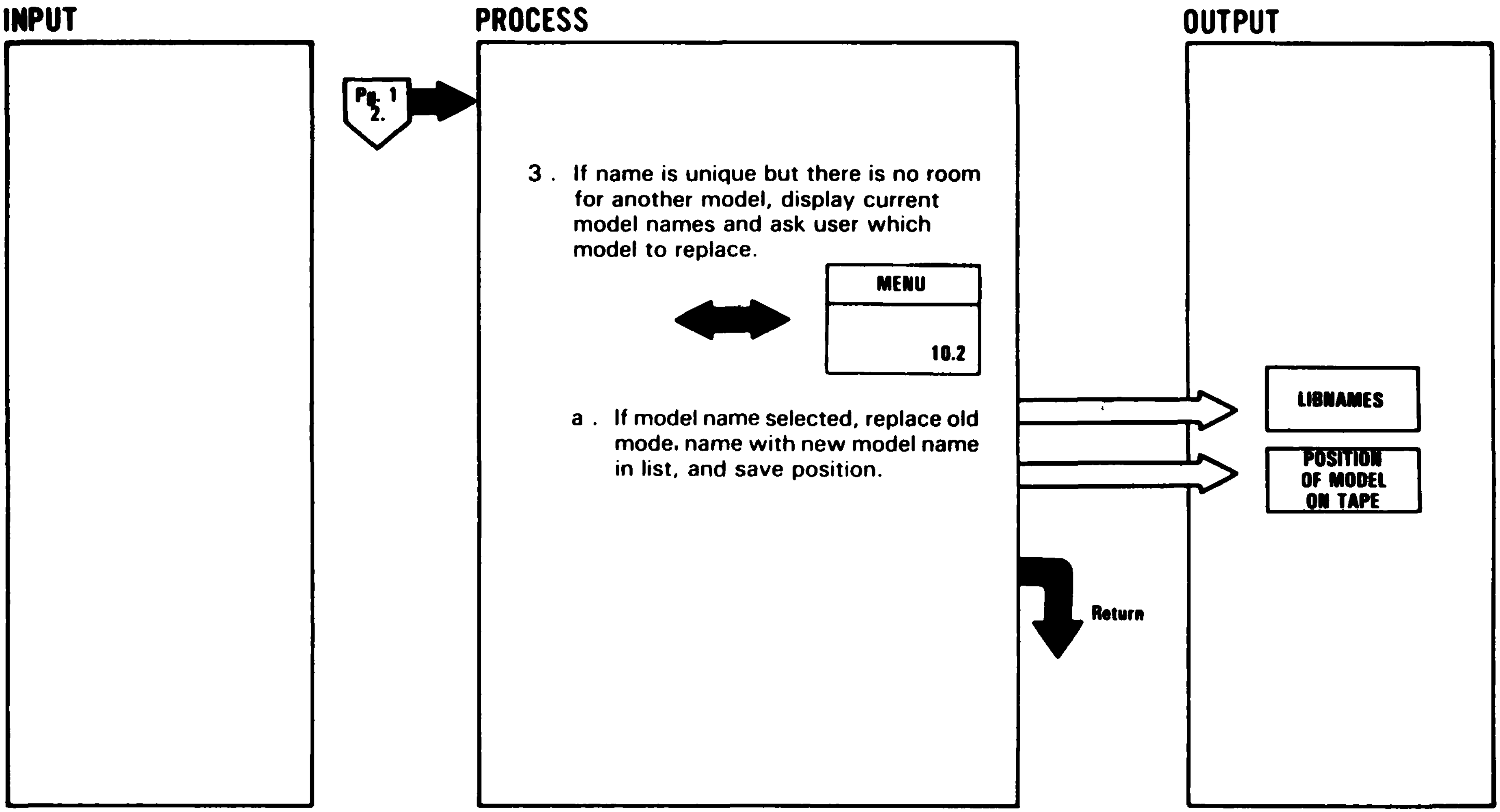
b . Find out if user wants to replace model with same name.

c . If no, indicate error.

2 . If name is unique and there is room on the tape for a new model, add model name to list and save position.

System/Program: RUN Name: FINDLOC

Diagram ID: 7.1 Description Determine Where to Save Model Page: 2 of 2

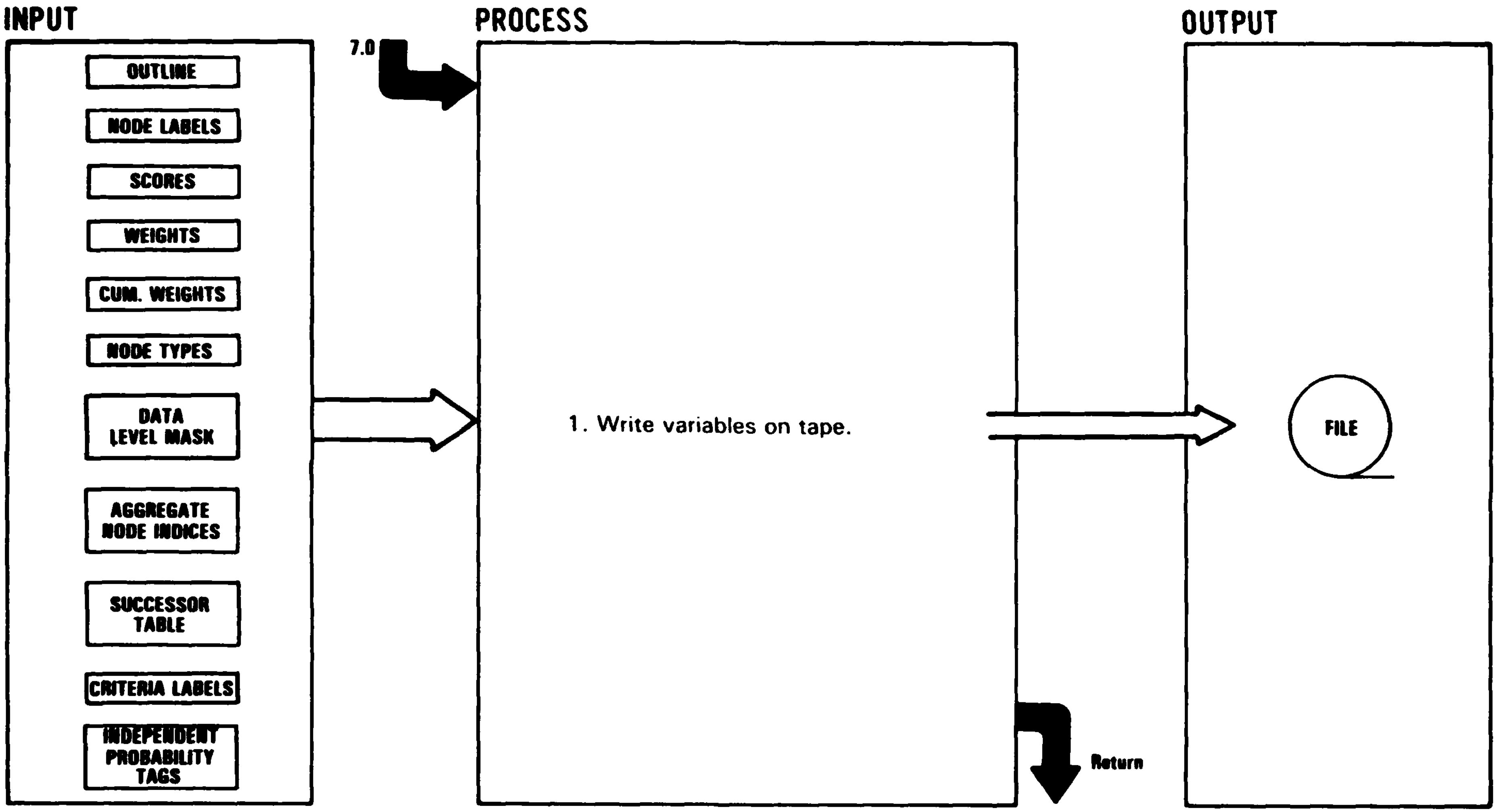


3 . If name is unique but there is no room for another model, display current model names and ask user which model to replace.

a . If model name selected, replace old mode. name with new model name in list, and save position.

System/Program: RUN Name: SAVE

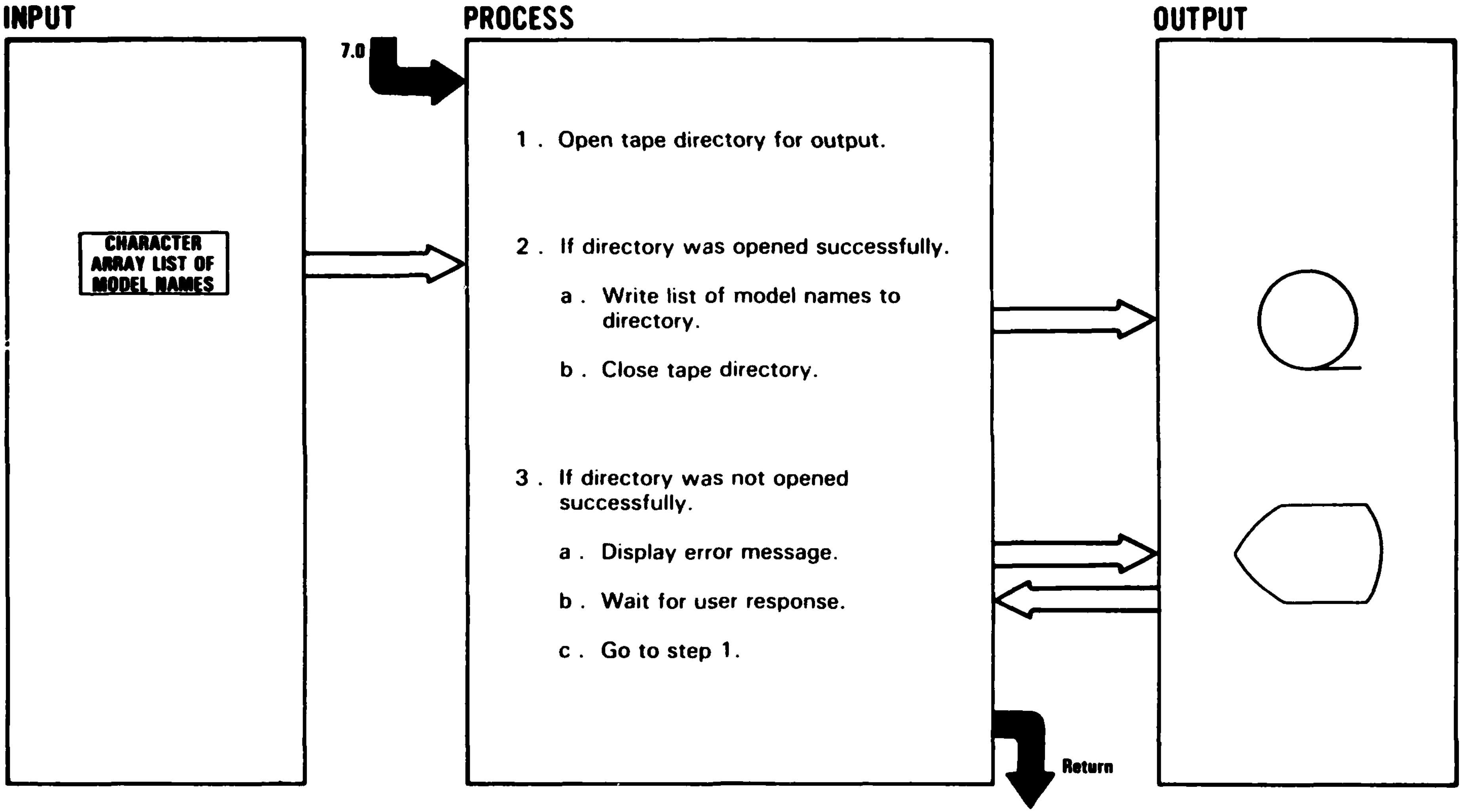
Diagram ID: 7.2 Description: Save Model Variables Page: ___ of ___



1. Write variables on tape.

System/Program: RUN Name: SAVLIB

Diagram ID: 7.3 Description Save Model Names Page: ___ of ___



1 . Open tape directory for output.

2 . If directory was opened successfully.

    a . Write list of model names to directory.

    b . Close tape directory.

3 . If directory was not opened successfully.

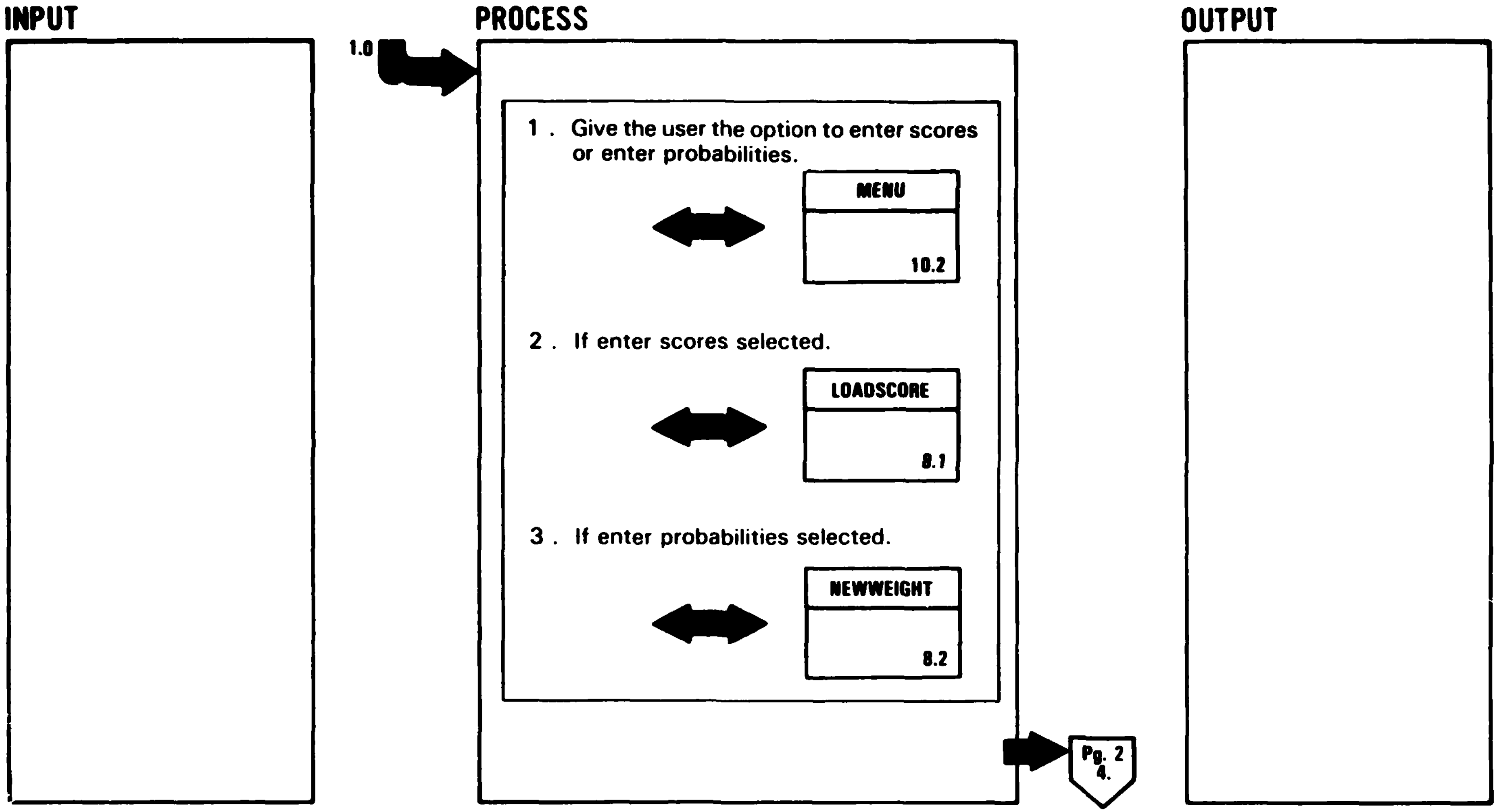
    a . Display error message.

    b . Wait for user response.

    c . Go to step 1.

System/Program: RUN Name: NEWDATA

Diagram ID: 8.0 Description: Enter New Values Page: 1 of 2



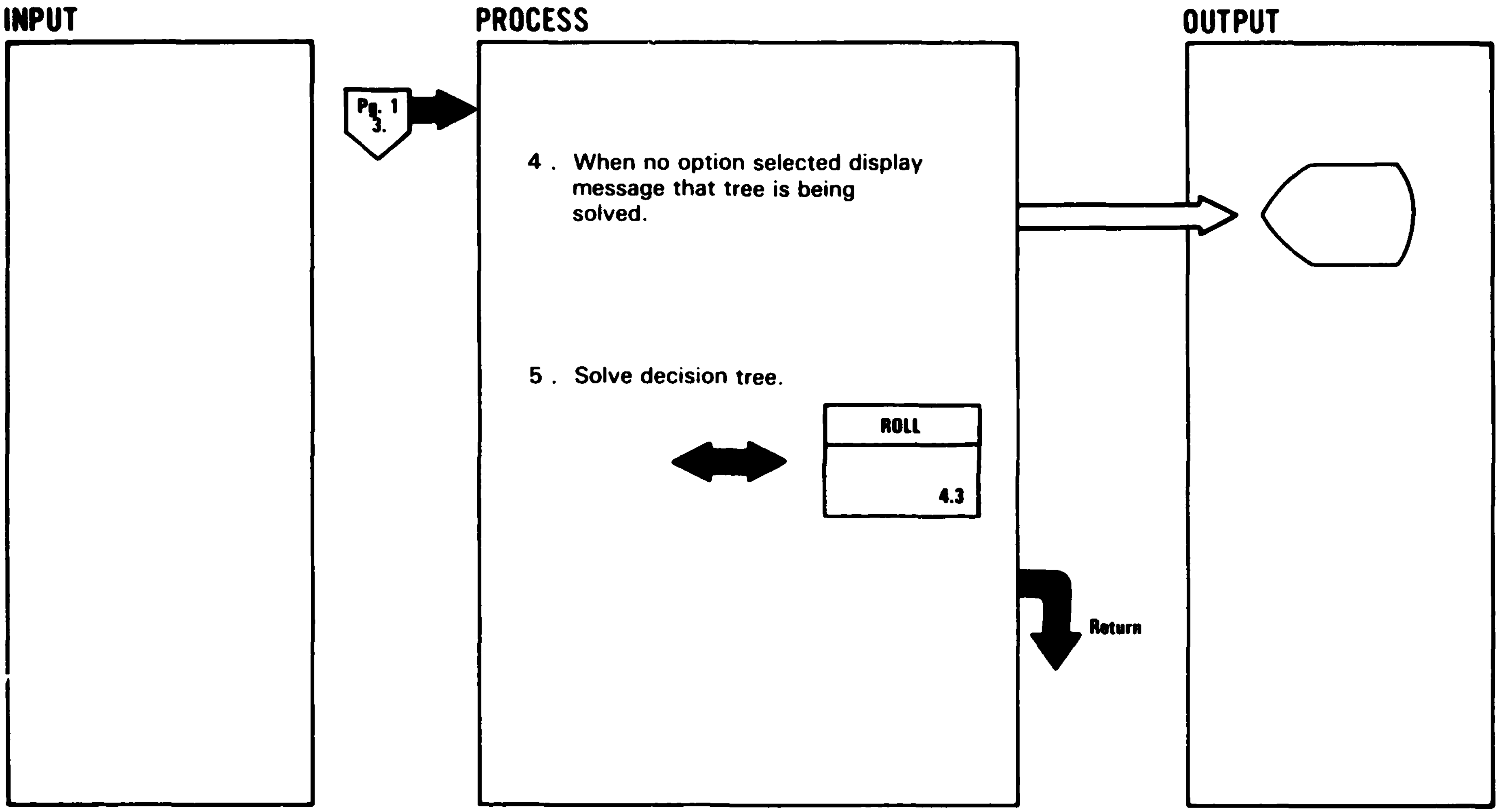
1 . Give the user the option to enter scores or enter probabilities.

2 . If enter scores selected.

3 . If enter probabilities selected.

System/Program: RUN Name: NEWDATA

Diagram ID: 8.0 Description: Enter New Values Page: 2 of 2

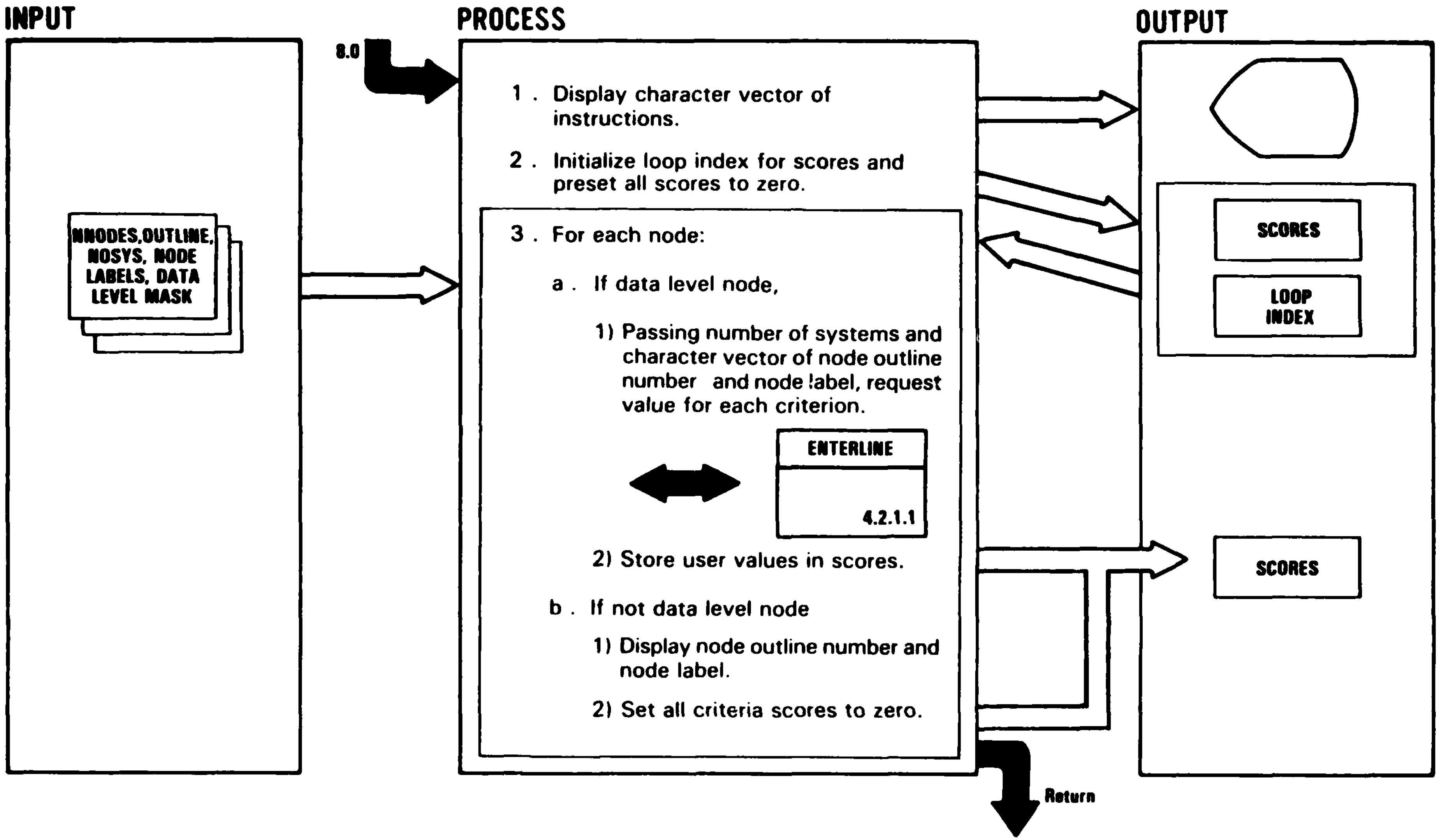


4 . When no option selected display message that tree is being solved.

5 . Solve decision tree.

System/Program: RUN Name: LOADSCORE

Diagram ID: 8.1 Description Enter All Scores Page: ____ of ____



1 . Display character vector of instructions.

2 . Initialize loop index for scores and preset all scores to zero.

3 . For each node:

a . If data level node,

1) Passing number of systems and character vector of node outline number and node label, request value for each criterion.

2) Store user values in scores.

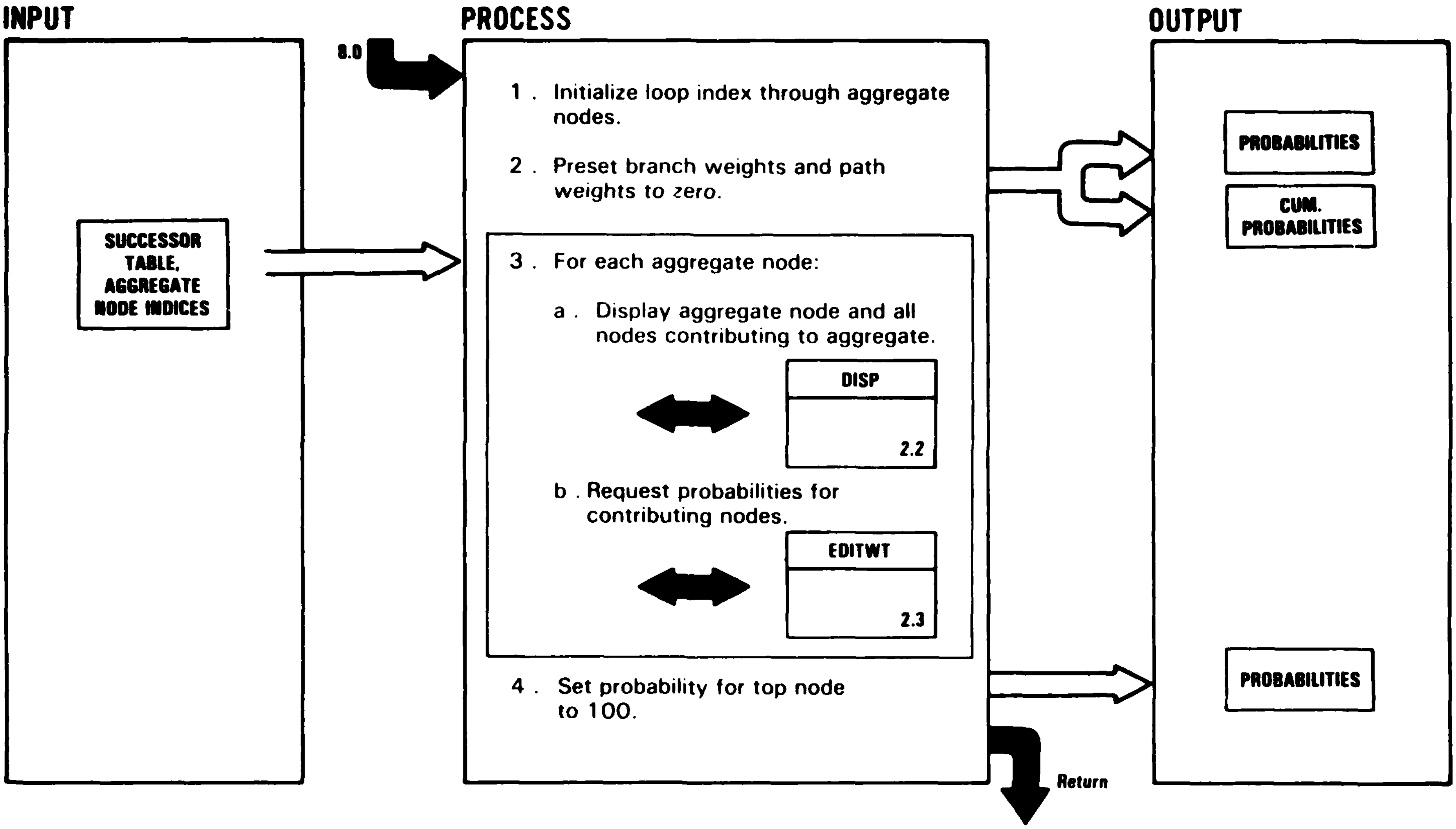
b . If not data level node

1) Display node outline number and node label.

2) Set all criteria scores to zero.

System/Program: RUN Name: NEWWEIGHT

Diagram ID: 8.2 Description: Enter All Probabilities Page: ____ of ____



1 . Initialize loop index through aggregate nodes.

2 . Preset branch weights and path weights to zero.

3 . For each aggregate node:

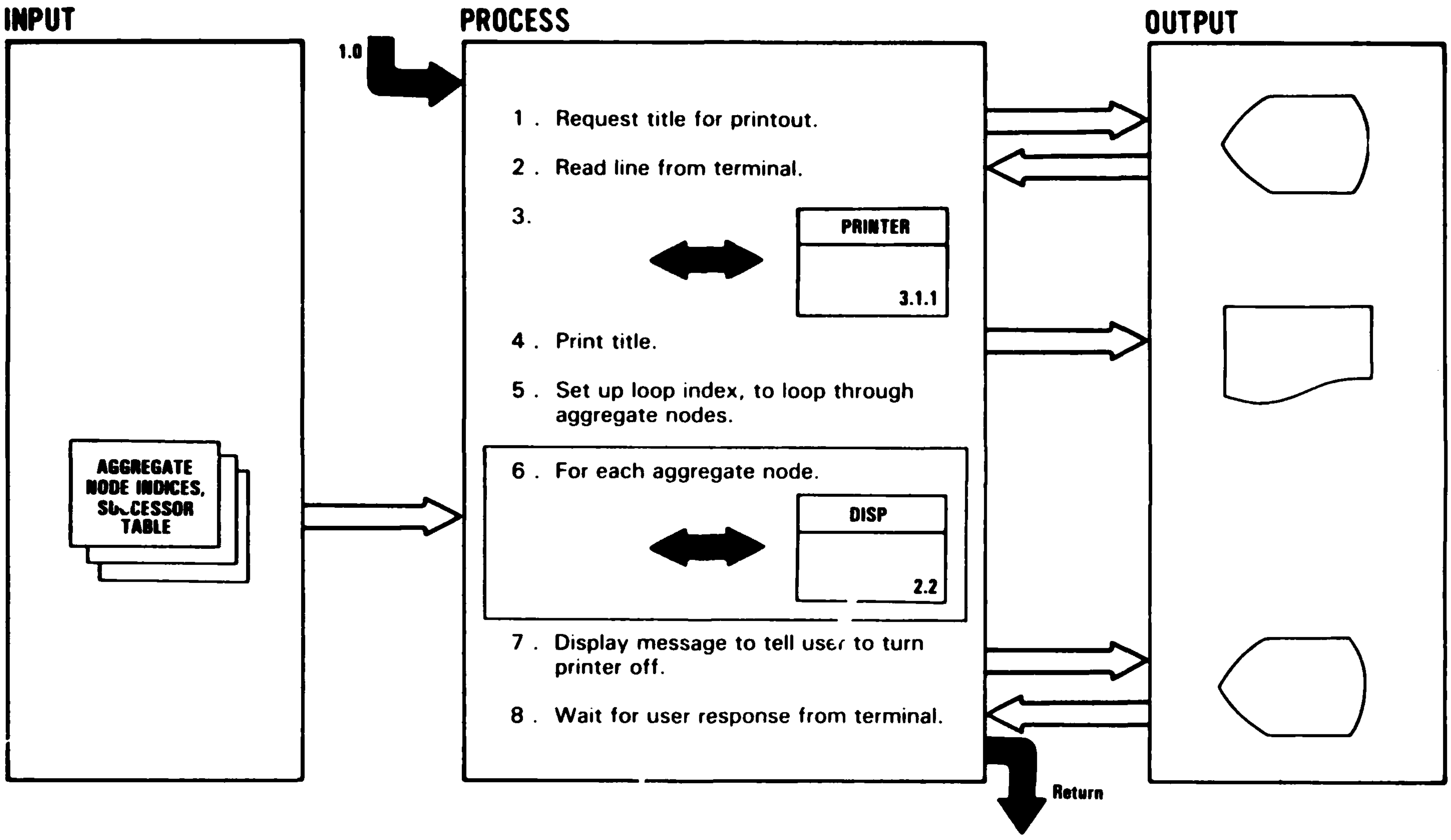
a . Display aggregate node and all nodes contributing to aggregate.

b . Request probabilities for contributing nodes.

4 . Set probability for top node to 100.

System/Program: RUN Name: SHOWALL

Diagram ID: 9.0 Description Print Results Page: ___ of ___



1 . Request title for printout.

2 . Read line from terminal.

3.

4 . Print title.

5 . Set up loop index, to loop through aggregate nodes.

6 . For each aggregate node.

7 . Display message to tell usei to turn printer off.

8 . Wait for user response from terminal.

System Program RUN Name ______

Diagram ID 10.0 Description General Routines Page ___ of ___

INPUT

PROCESS

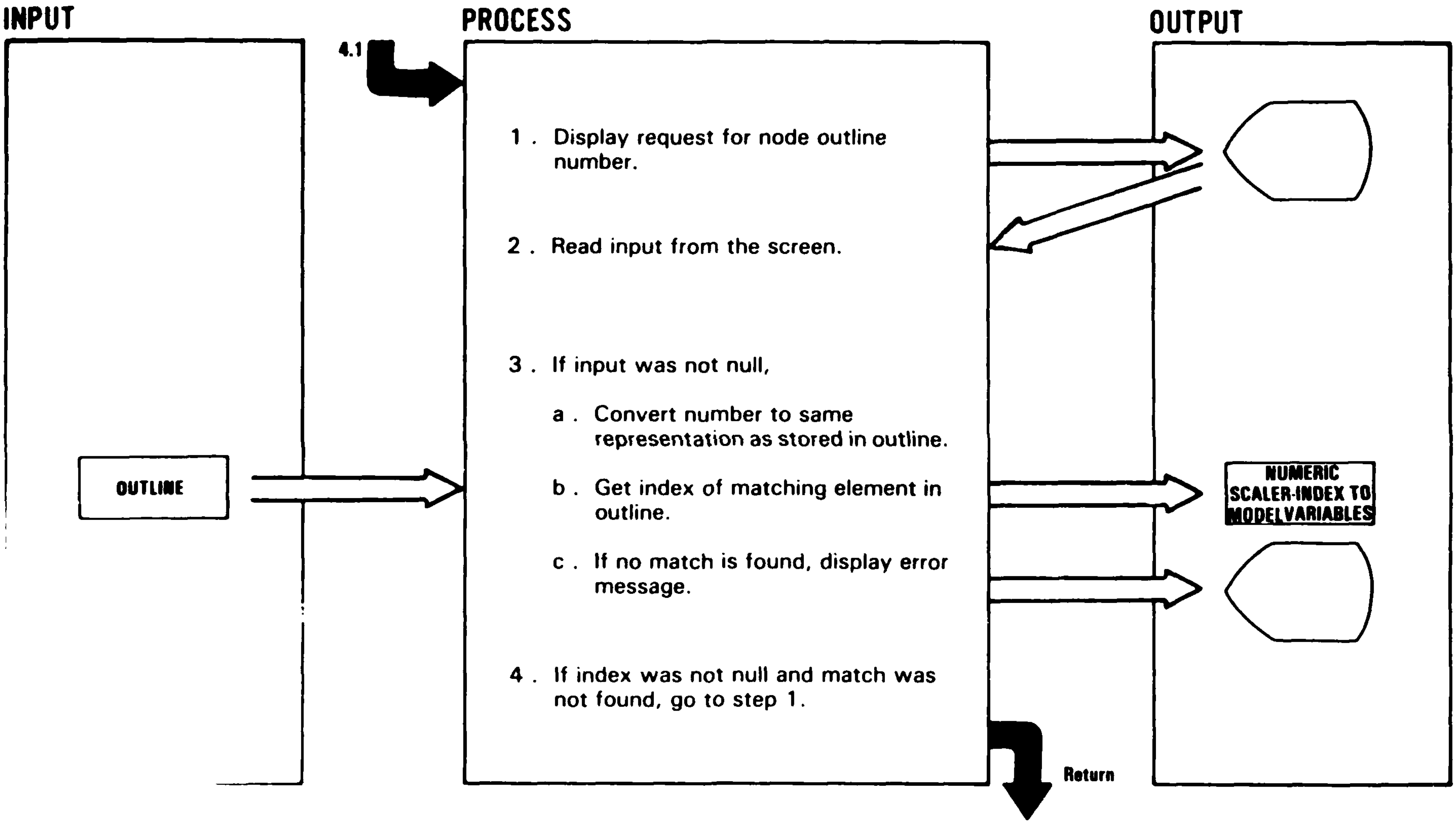
OUTPUT

**Extended Description**

Generalized routines are directly invoked by functional procedures and return to the calling programs.

System/Program RUN Name LOCATE

Diagram ID 10.1 Description Elicit Node Number Page ___ of ___



INPUT

PROCESS

OUTPUT

1 . Display request for node outline number.

2 . Read input from the screen.

3 . If input was not null,

a . Convert number to same representation as stored in outline.

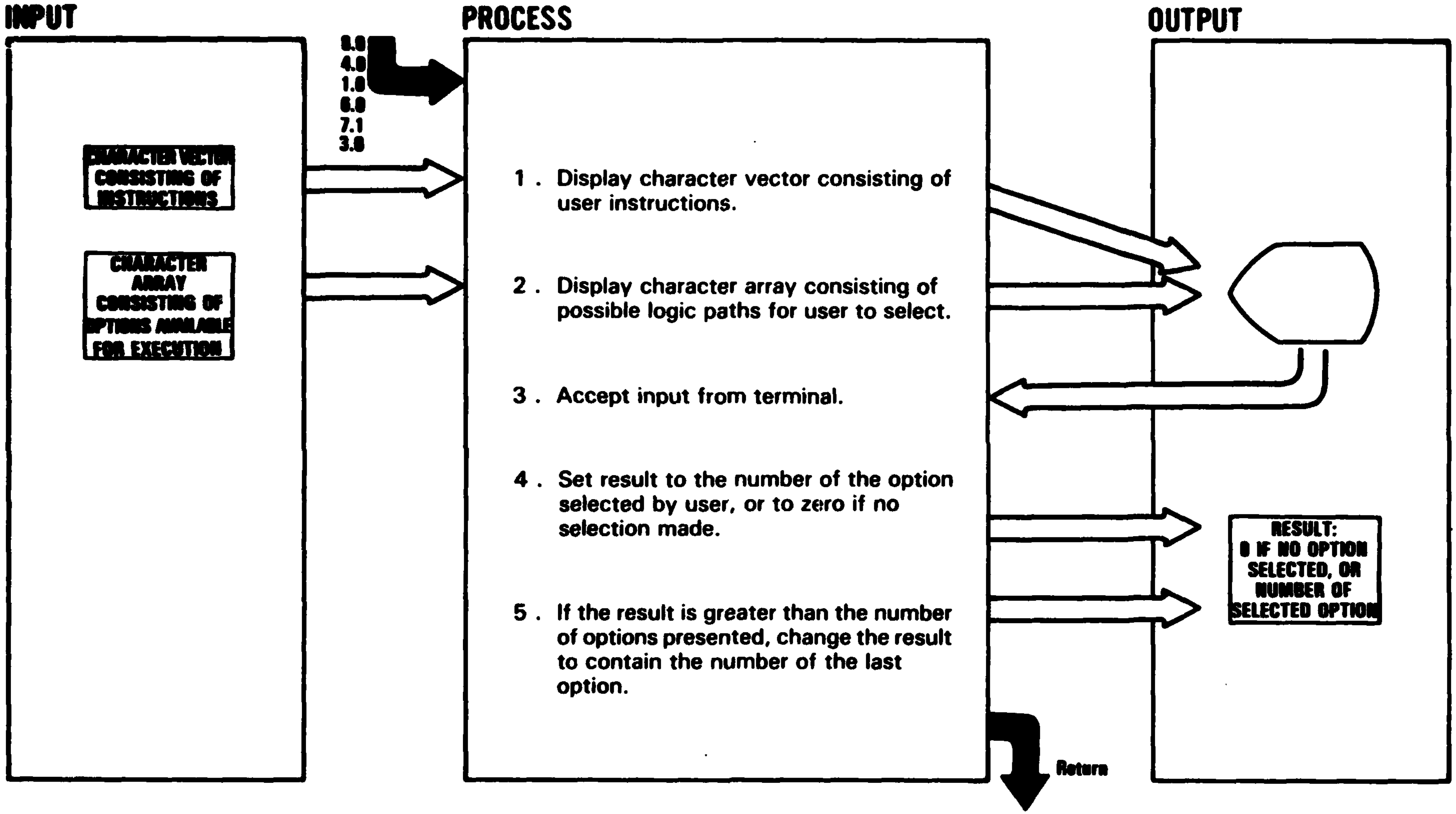
b . Get index of matching element in outline.

c . If no match is found, display error message.

4 . If index was not null and match was not found, go to step 1.

System/Program: RUN Name: MENU

Diagram ID: 10.2 Description Present User Options Page: ___ of ___



INPUT
CHARACTER VECTOR CONSISTING OF INSTRUCTIONS
CHARACTER ARRAY CONSISTING OF OPTIONS AVAILABLE FOR EXECUTION
8.0
4.0
1.0
6.0
7.1
3.0
PROCESS
OUTPUT
RESULT: 0 IF NO OPTION SELECTED, OR NUMBER OF SELECTED OPTION
Return

1 . Display character vector consisting of user instructions.

2 . Display character array consisting of possible logic paths for user to select.

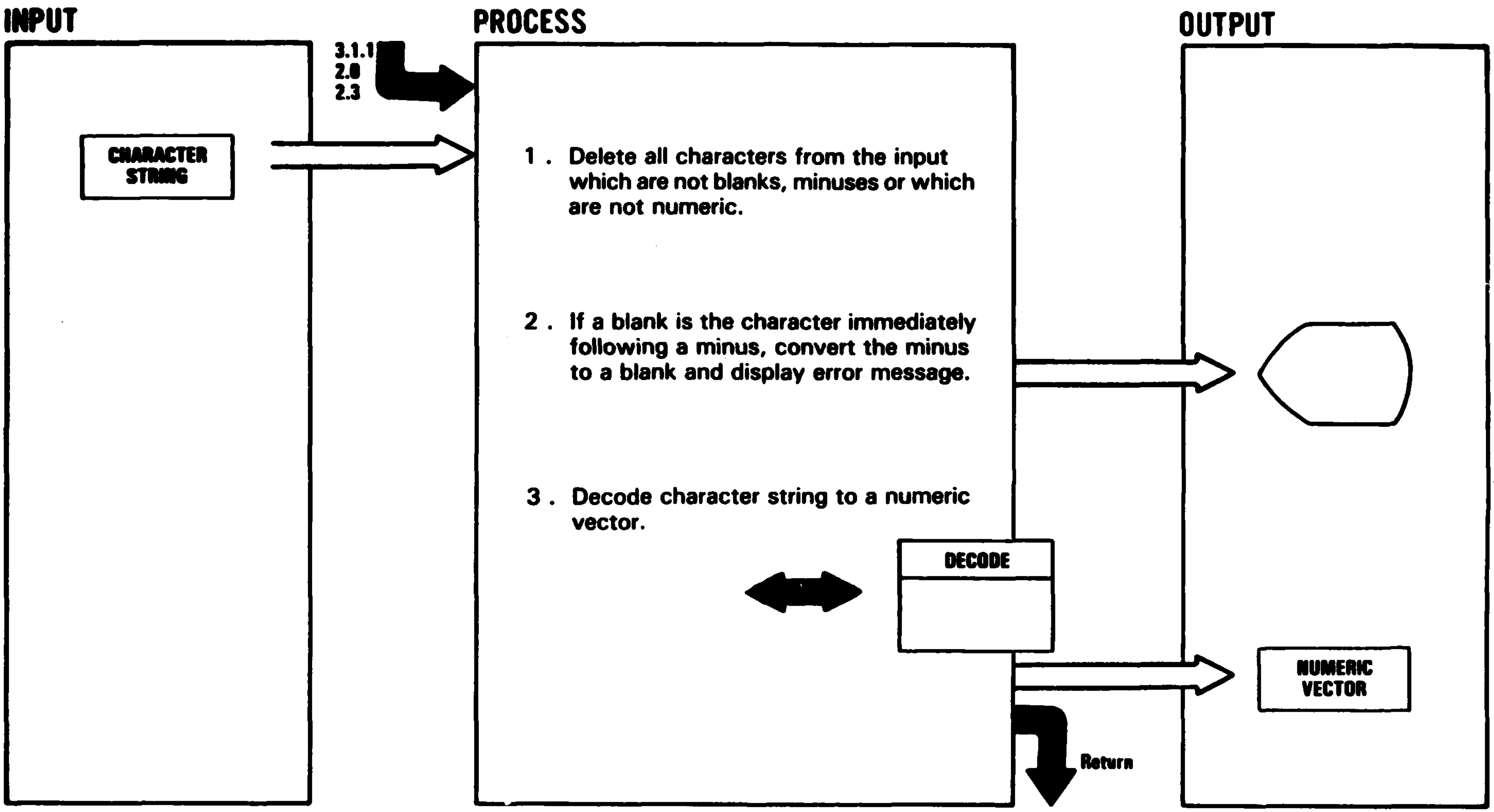
3 . Accept input from terminal.

4 . Set result to the number of the option selected by user, or to zero if no selection made.

5 . If the result is greater than the number of options presented, change the result to contain the number of the last option.

System/Program: RUN Name: NUMBERSONLY

Diagram ID: 10.3 Description Convert Alpha Numbers to Numeric Page: ___ of ___



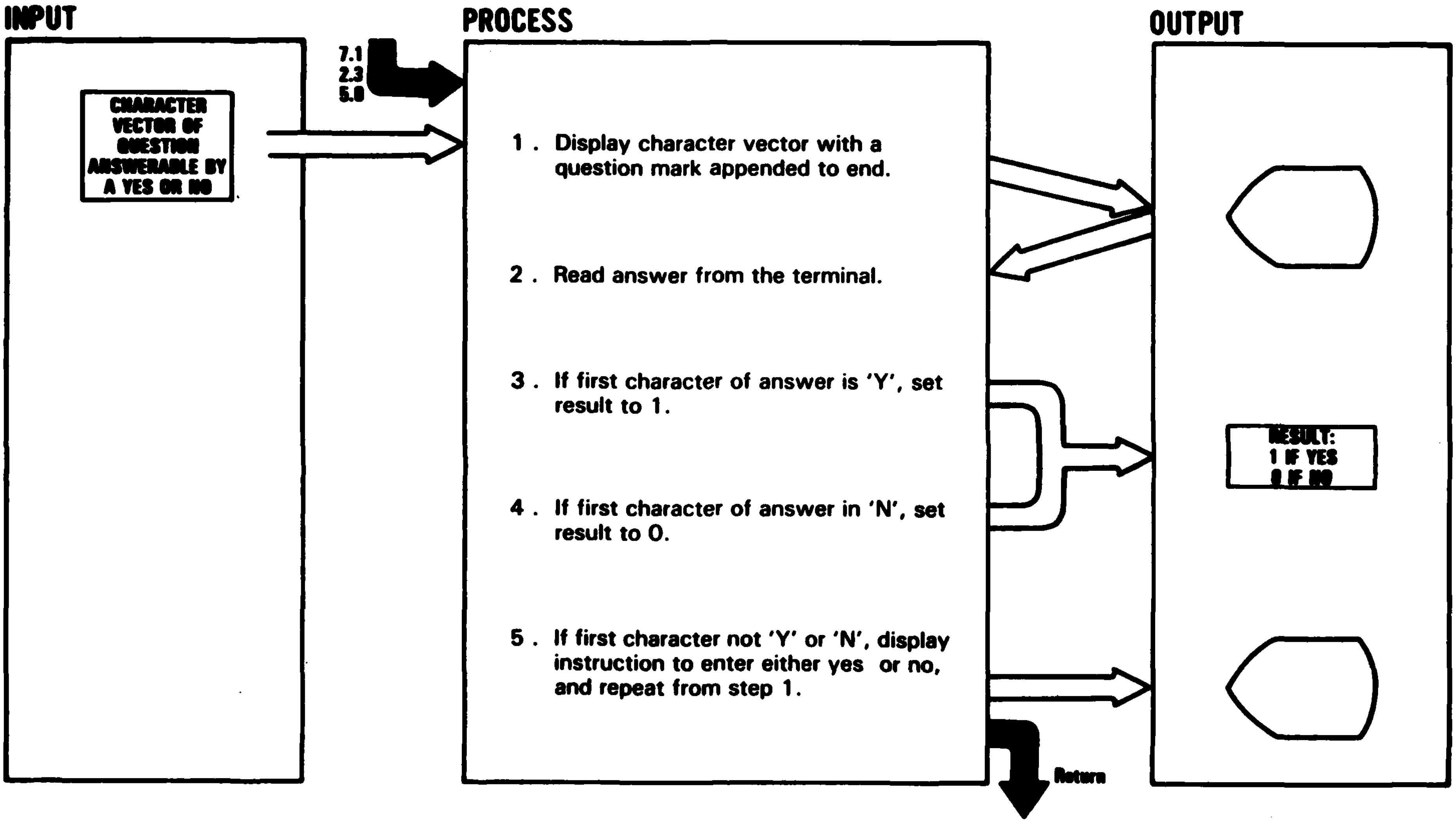
1 . Delete all characters from the input which are not blanks, minuses or which are not numeric.

2 . If a blank is the character immediately following a minus, convert the minus to a blank and display error message.

3 . Decode character string to a numeric vector.

System/Program: RUN Name: YESNO

Diagram ID: 10.4 Description Get Yes or No Answer Page: ___ of ___



INPUT

PROCESS

OUTPUT

1. Display character vector with a question mark appended to end.

2. Read answer from the terminal.

3. If first character of answer is 'Y', set result to 1.

4. If first character of answer in 'N', set result to 0.

5. If first character not 'Y' or 'N', display instruction to enter either yes or no, and repeat from step 1.